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ZOOLOGY.

ZOOLOGICAL GEOGRAPHY.*

THE NEOTROPICAL REGION, comprehending not only South America but Tropical North America and the Antilles, may be compared as to extent with the Ethiopian region; but it is distinguished from all the other great zoological divisions of the globe, by the small proportion of its surface occupied by deserts, by the large proportion of its lowlands, and by the altogether unequalled extent and luxuriance of its tropical forests. It further possesses a grand mountain range, rivalling the Himalayas in altitude and far surpassing them in extent, and which, being wholly situated within the region and running through eighty degrees of latitude, offers a variety of conditions and an extent of mountain slopes, of lofty plateaus and of deep valleys, which no other tropical region can approach. It has a further advantage in a southward prolongation far into the temperate zone, equivalent to a still greater extension of its lofty plateaus; and this has, no doubt, aided the development of the peculiar alpine forms of life which abound in the southern Andes. The climate of this region is exceptionally favorable. Owing to the lofty mountain range situated along its western margin, the moisture-laden trade winds from the Atlantic have free access

*From Wallace's Geographical Distribution of Animals. Part III. HARPER BROTHERS, New York.

to the interior. A sufficient proportion of this moisture reaches the higher slopes of the Andes, where its condensation gives rise to innumerable streams, which cut deep ravines and carry down such an amount of sediment that they have formed the vast plains of the Amazon, of Paraguay, and of the Orinooko out of what were once, no doubt, arms of the sea, separating the large islands of Guiana, Brazil, and the Andes. From these concurrent favorable conditions, there has resulted that inexhaustible variety of generic and specific forms with a somewhat limited range of family and ordinal types, which characterise neotropical zoology to a degree nowhere else to be met with.

Together with this variety and richness, there is a remarkable uniformity of animal life over all the tropical continental portions of the region, so that its division into sub-regions is a matter of some difficulty. There is, however, no doubt about separating the West Indian islands as forming a well-marked subdivision; characterized, not only by that poverty of forms which is a general feature of ancient insular groups, but also by a number of peculiar generic types, some of which are quite foreign to the remainder of the region. We must exclude, however, the islands of Trinidad, Tobago, and a few other small islands near the coast, which zoologically form a part of the main land. Again, the South Temperate portion of the continent, together with the high plateaus of the Andes to near the equator, form a well-marked subdivision, characterized by a peculiar fauna, very distinct both positively and negatively from that of the tropical lowland districts. The rest of Tropical South America is so homogeneous in its forms of life that it cannot be conveniently subdivided for the purposes of a work like the present. There are, no doubt, considerable differences in various parts of its vast area, due partly to its having been once separated into three or more islands, in part to existing diversities of physical conditions; and more exact knowledge may enable us to form several provinces or perhaps additional sub-regions. A large proportion of the genera, however, when sufficiently numerous in species, range over almost the whole extent of this sub-region wherever the conditions are favorable. Even the Andes do not seem to form such a barrier as has been supposed. North of the equator, where its western slopes are moist and forest-clad, most of the genera are found on both sides. To the south of this line its western valleys are arid and its lower plains almost deserts; and thus the absence of a number of groups to which verdant forests are essential, can be traced to the unsuitable conditions rather than to the existence of the mountain barrier. All Tropical South America, therefore, is here considered to form but one sub-region.

The portion of North America that lies within the tropics, closely resembes the last sub-region in general zoological features. It possesses hardly any positive distinctions; but there are several of a negative character, many important groups being wholly confined to South America. On the other hand many genera range into Mexico and Gautemala from the

north, which never reach South America; so that it is convenient to separate this district as a sub-region, which forms, to some extent, a transition to the Nearctic region. * * * * * *

The West Indian Islands are, in many respects, one of the most interesting of zoological *sub-regions*. In position they form an unbroken chain uniting North and South America, in a line parallel to the great Central American isthmus; yet instead of exhibiting an intermixture of the productions of Florida and Venezuela, they differ widely from both these countries, possessing in some groups a degree of specialty only to be found elsewhere in islands far removed from any continent. They consist of two very large islands, Cuba and Hayti; two of moderate size, Jamaica and Portorico; and a chain of much smaller islands, St. Croix, Anguilla, Barbuda, Antigua, Guadaloupe, Dominica, Martinique, St. Lucia, St. Vincent, Barbadoes and Grenada, with a host of intervening islets. Tobago, Trinidad, Margarita and Curaçao, are situated in shallow water near the coast of South America, of which they form part zoologically. To the north of Cuba and Hayti are the Bahamas, an extensive group of coral reefs and islands, seven hundred miles long, and although very poor in animal life, belonging zoologically to the Antilles. All the larger islands, and most of the smaller ones (except those of coral formation) are very mountainous and rocky, the chains rising to about 8,000 feet in Hayti and Jamaica, and to nearly the same height in Cuba. All, except where they have been cleared by man, are covered with a luxuriant forest vegetation; the temperature is high and uniform; the rains ample; the soil, derived from granitic and limestone rocks, exceedingly fertile; and as the four larger islands together are larger than Great Britain, we might expect an ample and luxuriant fauna. The reverse is however the case; and there are probably no land areas on the globe, so highly favored by nature in all the essentials for supporting animal life, and at the same time so poor in all the more highly organized groups of animals. Before entering upon our sketch of the main features of this peculiar but limited fauna, it will be well to note a few peculiarities in the physical structure of the islands, which have an important bearing on their past history, and will enable us to account for much that is peculiar in the general character of their natural productions.

If we draw a line immediately south of St. Croix and St. Bartholomew, we shall divide the archipelago into two very different groups. The southern range of islands, or the Lesser Antilles, are, almost without exception, volcanic; beginning with the small detached volcanoes of Saba and St. Eustatius, and ending with the old volcano of Grenada. Barbuda and Antigua are low islands of tertiary or recent formation, connected with the volcanic islands by a submerged bank at no great depth. The islands to the north and west are none of them volcanic; many are very large, and these have a central nucleus of ancient or granitic rocks. We must also note, that the channels between these islands are not of excessive depth, and that their outlines, as well as the direction of their mountain ranges, point to a former

union. Thus, the northern range of Hayti is continued westward in Cuba, and eastward in Portorico; while the southwestern peninsula extends in a direct line towards Jamaica, the depth between them being 600 fathoms. Between Portorico and Hayti there is only 250 fathoms; while close to the south of all these islands the sea is enormously deep, from more than 1,000 fathoms south of Cuba and Jamaica, to 2,000 south of Hayti, and 2,600 fathoms near the southeast extremity of Portorico. The importance of the division here pointed out will be seen, when we state that indigenous mammalia of peculiar genera are found on the western group of islands only; and it is on these that all the chief peculiarities of Antillian zoology are developed. * * * *

The scene of this illustration is Cuba, the largest of the West Indian islands, and one in which all its peculiar zoological features are well developed. In the foreground is the agouta (*Solenodon cubanus*), a remarkable insectiverous animal which, with another species inhabiting Hayti, has no allies on the American continent; nor anywhere in the world but in Madagascar, where a group of animals are found consisting of the family Centetidæ, to which *Solenodon* is said undoubtedly to belong. Above it are a pair of hutias (*Capromys fournieri*), rat-like animals belonging to the South American family Octodontidæ. They live in the forests, and climb trees readily, eating all kinds of vegetable food. Three species of the genus are known, which are found only in Cuba and Jamaica. Just above these animals is a white-breasted trogon (*Prionoteles temnurus*), confined to Cuba, and the only species of the genus. Near the top of the picture are a pair of todies (*Todus multicolor*), singular little insectiverous birds allied to the motmots, but forming a very distinct family which is confined to the islands of the Greater Antilles. They are beautifully-colored birds—green above, red and white beneath, and are exceedingly active in their movements. To the right are a pair of small humming-birds (*Sporadinus ricordi*), not very remarkable in this beautiful family, but introduced here because they belong to a genus which is confined to the the Greater Antilles. * *

THE NEARCTIC REGION consists almost wholly of Temperate North America as defined by physical geographers. In area it is about equal to the Neotropical region. It possesses a vast mountain range traversing its entire length from north to south, comparable with, and in fact a continuation of, the Andes—and a smaller range near the east coast, equally comparable with the mountains of Brazil and Guiana. These mountains supply its great river system of the Mississippi, second only to that of the Amazon; and in its vast group of fresh-water lakes or inland seas, it possesses a feature unmatched by any other region, except perhaps by the Ethiopian. It possesses every variety of climate between arctic and tropical; extensive forests and vast prairies; a greatly varied surface and a rich and beautiful flora. But these great advantages are somewhat neutralized by other physical features. It extends far towards the north, and there it reaches its greatest width; while in its southern and warmest portion it suddenly nar-

Plate XVII.

A Scene in Cuba, with Characteristic Animals.

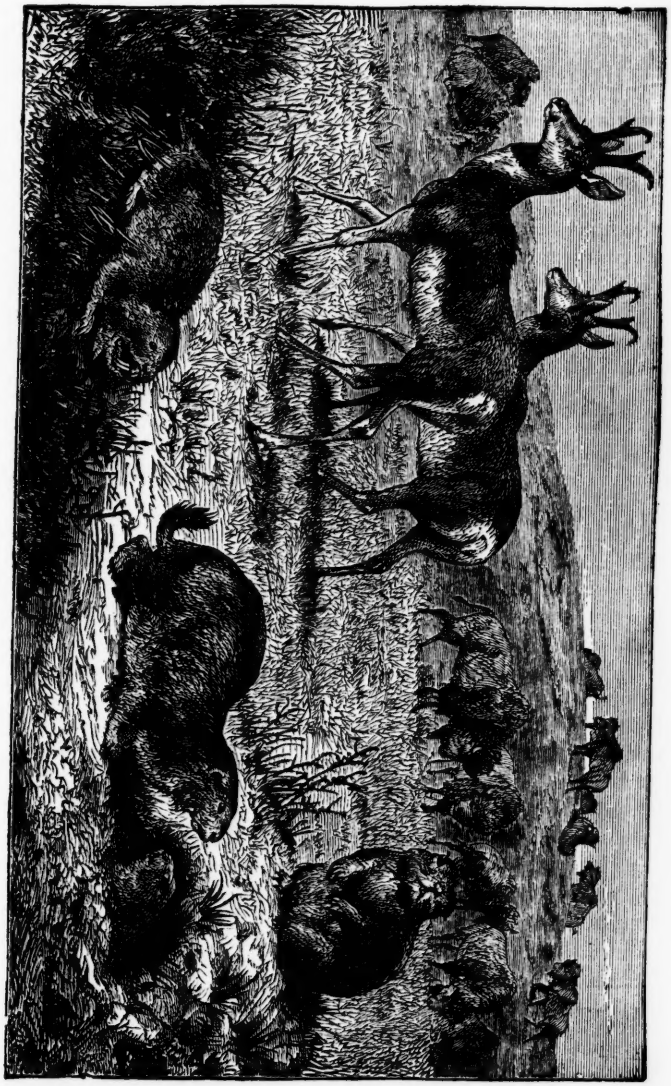
rows. The northern mass of land causes its isothermal lines to bend southwards; and its winter temperature especially, is far lower than at corresponding latitudes in Europe. This diminishes the available area for supporting animal life; the amount and character of which must be, to a great extent, determined by the nature of the least favorable part of the year. Again, owing to the position of its mountain ranges and the direction of prevalent winds, a large extent of its interior, east of the Rocky Mountains, is bare and arid, and often almost desert; while the most favored districts —those east of the Mississippi and west of the Sierra Nevada, bear but a small proportion to its whole area. Again, we know that at a very recent period geologically, it was subject to a very severe glacial epoch, which wrapped a full half of it in a mantle of ice, and exterminated a large number of animals which previously inhabited it. Taking all this into account, we need not be surprised to find the Nearctic region somewhat less rich and varied in its forms of life than the Palæarctic or the Australian regions, with which alone it can fairly be compared. The wonder rather is that it should be so little inferior to them in this respect, and that it should possess such a variety of groups, and such a multitude of forms, in every class of animals. * * * *

In our chapter on extinct animals, we have shown that there is good reason for believing that the existing union of North and South America is quite a recent occurrence; and that the separation was effected by an arm of the sea across what is now Nicaragua, with perhaps another at Panama. This would leave Mexico and Guatemala joined to North America, and forming part of the Nearctic region, although no doubt containing many Neotropical forms, which they had received during earlier continental periods; and these countries might at other times have been made insular by a strait at the isthmus of Tehuantepec, and have then developed some peculiar species. The latest climatal changes have tended to restrict these Neotropical forms to those parts where the climate is really tropical; and thus Mexico has attained its present strongly marked Neotropical character, although deficient in many of the most important groups of that region.

In view of these recent changes, it seems proper not to draw any decided line between the Nearctic and Neotropical regions, but rather to apply, in the case of each genus, a test which will show whether it was probably derived at a comparatively recent date from one region or the other. * * * *

The Central or Rocky Mountain sub-region is, for the greater part of its extent, from 2,000 to 5,000 feet above the sea, and is excessively arid; and, except in the immediate vicinity of streams and on some of the higher slopes of the mountains, is almost wholly treeless. Its zoology is therefore peculiar. Many of the most characteristic genera and families of the Eastern States are absent; while a number of curious desert and alpine forms give it a character of its own, and render it very interesting to the naturalist. * * * *

Plate XIX.



North American Prairies, with Characteristic Mammalia,

We here introduce four of the most characteristic mammalia of the great American plains or prairies, three of them being types confined to North America. The graceful animals on the left are the prong-horned antelopes (*Antilocapra americana*), whose small horns, though hollow like those of the antelopes, are shed annually like those of the deer. To the right we have the prairie-dogs of the trappers (*Cynomys ludovicianus*) which, as will be easily seen, are rodents, and allied to the marmots of the European Alps. Their burrows are numerous on the prairies, and the manner in which they perch themselves on little mounds and gaze on intruders, is noticed by all travelers. On the left, in the foreground, is one of the extraordinary pouched rats of America (*Geomys bursarius*). There are burrowing animals, feeding on roots; and the mouth is, as it were, double, the outer portion very wide and hairy, behind which is the small inner mouth. Its use may be to keep out the earth from the mouth while the animal is gnawing roots. A mouth so constructed is found in no other animals but in these North American rats. In the distance is a herd of bisons (*Bison americanus*), the typical beast of the prairies. * * *

The remaining part of this volume will consist of a systematic review of the distribution of each family of animals, and an application of the principles already established to elucidate the chief phenomena they present. The present chapter must, therefore, be considered as the conclusion of the argumentative and theoretical part of the present work; but it must be read in connection with the various discussions in Parts II. and III., in which the conclusions to be drawn from the several groups of facts have been successively given; and especially in connection with the general observations at the end of each of the six chapters on the Zoological Regions.

The hypothetical view, as to the more recent of the great geographical changes of the earth's surface, here set forth, is not the result of any preconceived theory, but has grown out of a careful study of the facts accumulated, and has led to a considerable modification of the author's previous views. It may be described as an application of the general theory of Evolution, to solve the problem of the distribution of animals; but it also furnishes some independent support to that theory, both by showing what a great variety of curious facts are explained by its means, and by answering some of the objections, which have been founded on supposed difficulties in the distribution of animals in space and time.

It also illustrates and supports the geological doctrine of the general permanence of our great continents and oceans, by showing how many facts in the distribution of animals can only be explained and understood on such a supposition; and it exhibits, in a striking manner, the enormous influence of the Glacial epoch, in determining the existing zoological features of the various continents.

And, lastly, it furnishes a more consistent and intelligible idea than has yet been reached by any other mode of investigation, of all the more im-

portant changes of the earth's surface that have probably occurred during the entire Tertiary period; and of the influence of these changes, in bringing about the general features, as well as many of the more interesting details and puzzling anomalies of the Geographical Distribution of Animals.

MINERALOGY.

ANTIQUE MARBLES.

Nothing more forcibly attests the imperial power and magnificence of Rome, at the height of her glory, than the fragments of precious marble which almost every excavation among her ruins brings to sight. Even if her history were lost to us, these varied bits of stone would tell in language stronger than words the story of her universal dominion, when her ships sought every clime, and every land paid tribute to her luxury. This piece reflects the glowing suns of Numidia, that the green of Tempe's Vale; this was quarried on Pentelicus, this in storied Chios, and these tell of Gallic and of Hispanic conquest. Many have a double history, having served to decorate some forum or temple of the East before its spoilation by a Mummius or a Sulla.

Toward the end of the second century B. C. the Romans, who had become conversant with Greek art through their conquests, began to appreciate sculptures and precious marbles, and from that time onward almost every captured city was rifled of its treasures. Not only were all the quarries of the world put under contribution, but statues, columns and capitals, slabs, pavements, and sometimes entire edifices, were transported to Rome. Carthage, from the time of its destruction, furnished an almost inexhaustible supply. Edrisi, the Arab geographer of the twelfth century, says that marbles of so many different species were found among its ruins that it would be impossible to describe them. Blocks thirty feet high and sixty-three inches in diameter, and columns thirty feet in circumference, were taken out.

A large fleet of vessels was employed solely in transporting marbles, and slaves or freedmen were stationed in the various ports from which they were sent, who were charged with the duty of keeping account of the number, quality, and date of shipment of all stones. In 1868, excavations on the banks of the Tiber brought to light the ancient *marmorata*, or marble-wharf, where these vessels landed their cargoes. Many blocks of precious colored marbles were exhumed here, some of colossal proportions. One of yellow African marble was twenty-seven feet long by five and a half feet wide, and weighed thirty-four tons. Another, sent from a then newly-

opened quarry in the mountains north of the Adriatic, to the Emperor Nero, was marked with the name of his freedman Carynthus.

So immense was the store of marbles amassed in Rome that for centuries after her spoilation by the northern barbarians her ruined edifices were regarded as the richest of quarries, from which pope, nobles and peasants drew at will. Most of the mediæval churches and other public edifices now extant are decorated with the spoils of imperial palaces, basilicas, baths, and the temples of the gods. Vast quantities of marble were even burned for lime; and, as if in retribution, Rome was robbed to beatify other cities. Her sculptured marbles were transported to Aix la-Chapelle to decorate the buildings of Charlemagne, and the ancient capital of the world, Petrarch laments, was forced to adorn from her own bowels the slothful luxury of Naples.

Of the white marbles of antiquity the most important were the Parian and the Pentelic, both the product of Greek quarries. The Parian was obtained from Mount Marpessa, in the island of Paros, one of the Cyclades, whence it was sometimes Marpessian. It was also called *lychnites*, because, says Pliny, the quarries were worked by lamplight. Dodwell disputes this, averring that the quarries are cut down the mountain side and open to the light; and he suggests that the marble was so called from its glittering fracture, or its translucence. This leads one to doubt whether Dodwell ever visited them, for Bory Saint-Vincent, of the French commission to the Morea, expressly describes them as subterranean, and says the entrance of the principal one was so filled up at the time of his visit that he was obliged to creep to enter it. There are three quarries on the mountain, and the largest has several lateral cuttings. The marks of the ancient wedges are everywhere visible, and it is evident from the manner in which the blocks were taken out that the utmost care was exercised to avoid waste. In consequence of the numerous fissures through the beds, comparatively small blocks could be obtained, generally not more than five feet in length.

Parian marble is of a yellowish white, very near the tint of white wax. Theocritus compares it to the color of teeth. It was, therefore, considered better adapted for the representation of human flesh than any other material. Its grain is much coarser than that of the Pentelic marble, but it takes a most exquisite polish, and, as it gradually hardens by exposure to atmospheric air, it resists decomposition for ages. To this quality is attributable the fine state of preservation of many of the most celebrated of the antique statues, such as the "Venus de' Medici, the "Diana Venatrix," the "Juno Capitolina," and "Ariadne," and the colossal "Minerva"—otherwise called the "Pallas of Velletri"—all of which are of Parian marble.

The neighboring island of Naxos produced a white marble scarcely inferior to that of Paros, but exhibiting a little more advanced state of crystallization. The marble, too, of Tenos, an island north of Paros, and of Thasos, the most northerly of the Ægean group, was considered nearly equal to that of Paros. Chios, Lesbos, Samos, and several other islands of

the archipelago, also produced white marbles, generally of a more snowy white than the Parian. They are called usually by the Italians *marmo Greco.*

In the palmy days of Greek art the Athenians gave the preference to the Pentelic marble, rather than to that of Paros, probably because it was more accessible to Athens, the quarries being on Mount Pentelicus, only about eight miles from the city. It is finer in grain than the Parian, and is whiter, but it is less translucid, and it has a tendency to exfoliate under atmospheric influence, so that it loses in time its polished surface. It is marked, too, by occasional zones of greenish talc, whence it is called by the Italian sculptors *cipolino statuario*, from its resemblance to an onion (*cipola*). It is sometimes called also *marmo salino*, from its salt-like grains. The Parthenon, the Propylæa, the Erechtheum, and most of the other principal buildings of Athens, were constructed of Pentelic marble, and it was also the material of some of the most celebrated of the ancient statues, such as the "Venus" of the Capitol, the "Pallas" of the Albani villa, the "Indian Bacchus," and many portrait busts.

The Pentelic quarries, says Dodwell, are cut in perpendicular precipices in the side of the mountain. The marks of the tools are everywhere visible, and the tracks of the sledges on which the immense masses were drawn down the declivity to the plain are still to be seen. Several frustra of columns and other blocks lie at the base of the excavation, just as they were left by the ancient quarrymen. One of the larger excavations is worked now.

The Hymettan marble, from Mount Hymettus on the southeast side of Athens, was employed in Xenophon's time in the construction of temples, altars, shrines, and statues, throughout Greece, but especially in Athens. The Romans used it to a much greater extent than the Pentelic, partly because the quarries were nearer the sea, and partly because its peculiar tint became the fashion. It was of a much less brilliant white than the Pentelic, in some places becoming almost gray. It was used chiefly for buildings. According to Pliny, Lucius Scaurus was the first in Rome to decorate his house with Hymettan columns, 104 B. C. The statue of Meleager, in Paris, is made of this marble.

In the time of Julius Cæsar quarries of white marble were opened at Luna, on the coast of Eutruria, and thenceforth Rome drew her supply of building marbles from this place, almost to the exclusion of the Greek marbles. The Pantheon, and many other public buildings, were constructed of it. It was soon found to be adapted also for statuary, and finally came to be preferred to the Parian. The "Antinous" of the Capitol, now in the Paris Museum, is of this marble, and, according to some, the "Apollo Belvedere" also; but the Roman sculptors think the latter is a Greek marble. The marble of Luna, called by the ancients *marmor Lunense*, and which is the same as the modern Carrara, is whiter than either the Parian or Pentelic, and some of its veins are not inferior in beauty of grain and in softness to the former.

XUM

In 1847 a quarry of white marble was opened at Maremma, about thirty-five miles from Leghorn, which bore many evidences of having been worked in ancient times. It closely resembles the Parian in color and grain, works smoothly, and takes a high polish.

White marbles were also obtained by the ancients from Mount Phelleus, Rhamnus, and Sunium, in Attica; Demetrias, in Thessaly; on the river Sangarius, in Phrygia; from near Alexandria Troas; from Mount Prion, near Ephesus; from Cappadocia, and from Mount Libanus, the modern Lebanon.

The marbles of Phelleus, Rhamnus, and Sunium, were of good color, but were coarse, and less homogeneous than the Pentelic. The Sangarian marble was sometimes called Coralitic. The Cappadocian was called Phengites, on account of its translucence. The temple of Fortuna, built by Nero within the precincts of his Golden House, was built of this stone; and, although it had no windows, it is said to have been perfectly light when the door was closed. The marble of Mount Libanus, usually called Tyrian, was probably the material of Solomon's Temple and of Herod's palace. The *Scala Santa* in the Lateran Palace, Rome, said to have been brought from Pilate's house in Jerusalem, is of this marble, which is a clear blue-white.

The Proconnesian marble, a pure white with black veins, was quarried in the island of Proconnesus, in the Propontis. The celebrity of this stone has changed the name of the island to Marmora, and also given its modern name (Sea of Marmora) to the Propontis. This marble was also called Cyzican, because it was largely used in the city of Cyzicus, opposite the island of Mysia. The palace of Mausolus, at Halicarnassus, was built of it. It was also much used at Constantinople, under Honorius and the younger Theodosius. Several columns of it in the mosque of St. Sophia were spoils of the temple of Cybele at Cyzicus.

A white marble, with yellow spots, was brought from Cappadocia, and a similar marble from Rhodes, but the spots were of a brighter, more golden, yellow. White marble, with black spots, was quarried in the Troad.

But the most beautiful of the antique variegated marbles, with a white base, was the Synnadic, Docimæan, or Docimite, sometimes called *marmor Phrygium*. It was quarried at the village of Docimia, not far from Synnada, in Phrygia Major. The ancient authorities generally describe it as pure white, marked with red or purple veins, which the poets compared to the blood of Atys, slain at Synnada; but Hamilton, who visited the quarries about 1835, says that they yield several different kinds. He mentions white, bluish-white, white with yellow veins, white with blue veins, and white with blue spots, the latter having almost a brecciated appearance. He describes the principal quarry as worked horizontally into the hill, the sides of which are cut away perpendicularly to a great height to secure the splendid columns for which it was famous. Strabo says that pillars and slabs of surprising magnitude and beauty, approaching the alabastrite marble in variety of colors, were conveyed thence to Rome, notwithstanding

the long land-carriage of more than one hundred miles to the place of shipment. The quarries are entirely surrounded by trachytic hills, to which, says Hamilton, the marble "owes its crystalline and altered character, being to all appearance a portion of the older secondary limestone caught up and developed by the protruded volcanic rocks, and crystallized by igneous action."

The alabastrites marble of the ancients, or onychites, was not a marble proper, but a hard carbonate of lime, identical in composition with stalagmite, the modern alabaster. It was quarried, says Pliny, near Thebes, in Egypt, and Damascus. When first brought to Rome it was considered almost a precious stone, and was made into cups and small ornaments, such as the feet of couches and chairs. When Balbus decorated his theatre, in the time of Augustus, with four small columns of this stone, it was noted as an unprecedented occurrence; but, in the reign of Claudius, Callistus, a freedman of that emperor, adorned his banquet hall with thirty large columns of alabastrites. The ancient quarries were reopened by Mehemet Ali, Viceroy of Egypt, to obtain material to build his mausoleum at Cairo. The four magnificent pillars of this marble that support the baldacchino over the altar in the church of San Paolo fuori le Mura, in Rome, were presented by him. Each is a monolith forty feet long.

Of the yellow marbles of antiquity, that called by the Italians *giallo antico* is the rarest and most beautiful. There are several varieties of it, varying in tint from a cream-yellow to the deepest chrome-yellow, sometimes shading into red and purple hues. Some is as bright as gold (*giallo dorato*), some of an orange-shade (*giallo capo*), and some, extremely rare, of a canary-color (*giallo paglia*). The ancient writers compared it to saffron, to sunlight and to ivory grown yellow with age. Some of it is variegated with black or dark-yellow rings. The grain is exceedingly fine. Its colors are derived entirely from carbonaceous matter. Among the finest existing specimens of this marble are the large columns in the Pantheon at Rome, and a single pair in the Arch of Constantine. The *giallo antico* was called *marmor Numidicum* by the Romans, but the precise site of the quarries is not yet ascertained. M. Fournel believes that the yellow marble of Philippeville, Algeria, which closely resembles it in varying tint, is identical with it. The island of Molos and Corinth also produced yellow marbles, and in the time of Justinian a marble of a fiery yellow was quarried in the neighborhood of Jerusalem.

Among the most celebrated marbles of the ancient world was the *rosso antico*, or red antique. Its color passes from a red, almost scarlet, to a wine-lees or blood-red, which is divided by parallel layers of white, and sometimes also intersected by a network of delicate black veins. Its variation in tint is probably according to the quantity of the oxide of iron contained in it. Until lately this marble was known only through its remains, and it has generally been ascribed to Egypt. The largest ancient specimens preserved are the fourteen slabs composing the double flight of steps

in the church of San Prassede, Rome. Napoleon I. at one time intended to carry these to Paris to ornament his throne. There are several statues of *rosso antico*, including the "Antinous" in Paris, and the "Marcus Agrippa" in the Grimani Palace, Venice, and many medallion portraits. It is now ascertained that this beautiful marble was not Egyptian, but Greek. It was quarried on the coast of the gulf of Laconia, near what is now the bay of Scutari. The quarry lies near the sea, and large blocks cut by the ancients are still to be seen there. In 1851 the Greek government sent specimens from it to the London Exposition, and it was fully recognized as the *rosso antico*.

There are many varieties of the marble called red and white antique, but they are so near alike that it is impossible to distinguish them by description alone. They are variously called by the Italians *rosso annulato*, *serpentelo*, *vendurino*, *fiorito*, *cotonello*, etc. They are found only in the Roman ruins, and their quarries are unknown. The marble called *cervelas* is of a deep red, with numerous gray and white veins. It is supposed to have been brought from Africa.

The ancients were acquainted with many kinds of green marble, one of the most noted of which was the *marmor Atracium*, called by Julius Pollux Thessalian, and identical with the *verde antico* of the Italians. The quarries were on Mount Ossa, near the entrance of the vale of Tempe, and not far from Atrax in Thessaly, whence it derived its name. It is a species of breccia, whose paste is a mixture of talc and limestone, interspersed with fragments of white marble. But the verde antique marbles differ from the modern breccias in that the colors are so blended that the line of demarkation is not perceptible. The Erechtheum in Athens was adorned with columns of verde antique, and it was one of the marbles selected by Justinian for the decoration of St, Sophia. The eight splendid columns of it still to be seen in the mosque are said to have been taken from the temple of Diana at Ephesus.

The celebrated Carystian marble, the *cipolino verde* of the Italian, derived its name from Carystus, a town at the foot of Mount Oche, in the island of Eubœa, where it was quarried. The temple of Apollo Marmarinus of Carystus was named from this quarry. It is a true steatitic limestone or cipolin, and is of a beautiful grayish green, with white zones and spots, and sometimes sprinkled with different colors. It was easily obtained in very large blocks, suitable for columns, and was largely used in the temples and other public buildings in Athens and Rome. An English traveler, who visited the quarry lately, found seven entire columns on the site, about three miles from the sea, just as they were left by the ancient workmen,

The *marmor Lacedæmonium*, *Laconicum*, or *Spartum*, of the Romans has always been regarded as a species of verde-antique marble. Clarke says that it differed from the Atracian only in being variegated with black or dark-green serpentine instead of with white. But M. Boblaye, the mineralogist of the French commission to the Morea, has proved pretty conclu-

sively that it was not a marble but a true porphyry, and probably identical with the *ophites* of the ancients, which Pliny says was so called from its resemblance to the skin of a serpent. Pausanias calls it Crocean stone. The French discovered the quarries near the ancient Croceæ, on the road from Sparta to Gythium, and about two miles from the modern village of Levétzova, in Laconia. The stone is of a dark grass-green, strewed with little parallelograms of a lighter green, sometimes approaching white and sometimes yellow. Procopius compares its color to emerald, and Statius and Sidonius call it a grass-green. Eurycles, the Spartan architect, used this stone in decorating the baths of Neptune at Corinth; and it was quarried to a large extent by the Romans, who enriched the monuments of Greece, Italy and Gaul, with it.

The Augustan and Tiberian marbles, so fashionable in Rome under those emperors, were obtained in Egypt. They are breccias composed of fragments of greenstone, gneiss and porphyry cemented with a calcareous paste. They are similar in color, a bright green, spotted and streaked with dark green, reddish gray and white; the only difference being, according to Pliny, that in the Augustan the figures undulate and curl to a point, while in the Tiberian the streaks are not involved, but lie wide asunder. It is probable that these marbles were quarried in the mountains between Thebes and the Red Sea. Inscriptions in the ancient quarries there, near the well of Hammamat, show that they were worked in the sixth dynasty of Manetho. A green marble called Memphites was quarried near Memphis in Egypt.

There were many other varieties of green marble known to the ancients, such as the red-spotted green antique, having a dark-green ground marked with small red and black spots and white fragments of *entrochi;* the *marmo verde pagliocc*, yellowish green; and leek marble, of the color of a leek; but they exist only in small fragments, and their quarries are unknown. Another variety of green marble was found in the island of Tenos.

A blue marble is said to have been obtained in Libya. The island of Naxos yields a dark blue elegantly striped with white, Tenos a light blue veined with dark blue, and Scyros many kinds of blue and violet breccias, with other colors variously disposed. Scyros was one of the chief places whence the ancients derived their variegated marbles, and its quarries furnished many varieties closely resembling the famous marbles of other localities. Strabo says it produced the Carystian, Deucalian, Synnadic, and Hierapolitic marbles. The quarries of Tenos are still worked to some extent, but those of Scyros and Naxos remain almost as the ancients left them.

Of the black marbles of antiquity that now called *nero antico*, or black antique, was the most celebrated. It is more intensely black than any marble now quarried, the black marbles of France appearing almost gray beside it. It occurs only in sculptured pieces, and its origin is unknown; but Faujas discovered a quarry which had been worked by the ancients,

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about two leagues from Spa, not far from Aix-la-Chapelle, the marble of which closely resembles the ancient specimens. The largest masses known of *nero antico* are two columns in the church of Regina Cœli at Rome, but there are also some fine specimens in the Museum of the Capitol and in other collections. Some suppose it to be indentical with the *marmor Lucullum*, which was introduced at Rome, by Lucullus, in the first century B. C., according to Pliny from Melos (another reading is Chios), but according to other authorities from Egypt or Libya, whence it is sometimes called *marmor Libycum*. Pliny says that Marcus Scaurus had pillars of it thirty-eight feet high in the atrium of his house. The Chian marble, a deep, transparent black, sometimes variegated with other colors, was quarried on Mount Pelinæus, in the island of Chios. A fine black marble was quarried on Mount Tænarus, in Laconia, and in the island of Lesbos, and a blue-black marble in Lydia. One of the most beautiful of the antique breccias, the African breccia, has a deep-black ground, variegated with fragments of grayish white and deep red or purplish wine-color. The grand antique breccia consists of large fragments of black marble united by veins of shining white. Columns of this and of African breccia are in the Paris Museum, but their quarries are unknown.—JOHN D. CHAMPLIN, JR., *in Popular Science Monthly*, May, 1877.

THE MINERAL RESOURCES OF MISSOURI

The growth of Missouri in population, wealth, material progress, in the means of intercommunication by her rail and water ways, challenges the admiration of the civilized world. The State of Missouri is larger in its area than the States of Maine, New Hampshire, Vermont, Rhode Island and Connecticut together, Missouri having an area of 67,380, while the New England States embrace but 66,124 square miles. Missouri has a greater variety of soil, a more genial climate and a more desirable combination of the elements that tend to the permanent prosperity of a people than any of the other States in the Union. Doubly blessed is she indeed; with her certain harvest of rich crops on the surface, and her boundless mineral wealth overflowing nature's storehouse beneath.

Missouri within her boundaries contains a greater variety and larger quantities of the most useful minerals than any other territory of the same extent on the American Continent.

Coal and iron afford the most permanent basis of commercial and manufacturing prosperity. It is the coal and iron deposits that have contributed in the greatest measure to the building up of the most powerful nations of the earth, and it is not difficult to see the magnificent future of this great State, when her mineral interests shall be as thoroughly organized and perfectly systematized as are these interests in the old world. A celebrated writer says and truly, that "Coal is now the indispensable aliment of in-

dustry: it is a primary, material, engendering force, giving a power superior to that which natural agents, such as water, air, etc., procure. It is to industry what oxygen is to the lungs, water to the plants, nourishment to the animal. It is to coal that we owe steam and gas. Our coal fields have an area of 26,800 square miles of the regular coal measures, extending through thirty-three counties of the State, viz: Clark, Lewis, Scotland, Adair, Macon, Shelby, Monroe, Audrain, Callaway, Boone, Cooper, Pettis, Henry, Benton, St. Clair, Bates, Vernon, Cedar, Dade, Barton, Johnson, Lafayette, Cass, Chariton, Howard, Saline, Putnam, Carroll, Ray, Ralls, Montgomery, Warren and St. Louis. Now, if the average thickness of workable coal be one foot only, it would give 26,800,000 tons to the whole area occupied by coal rocks. Experience shows us that we can depend on five feet average thickness as the least possible result, which would give us 134,000,000 tons of good coal. Besides, we have local deposits of cannel and bituminous coal in Moniteau, Cole, Morgan, Crawford, Lincoln, Callaway and probably in other counties. Missouri contains an almost inexhaustible supply of iron ores of the best qualities and more available than can be found in any other place on the globe, and even now in the infancy of its development, there is more capital invested in the mining, shipping, smelting and manufacturing of the ores of iron than in all the other metal industries of the State. The iron ores of Missouri are red hematite, red oxide, specular, brown hematite or limonite, hydrous oxide, oxidulous or magnetic, spathic or carbonate of iron, and almost every other character and condition of iron known. Iron has been discovered in 62 counties of the State, in 19 of which it is being successfully mined, viz: Benton, Camden, Cedar, Crawford, Dent, Franklin, Henry, Iron, Madison, Maries, Miller, Morgan, Perry, Phelps, St. Francois, Saline, Shannon, Taney and Wayne. There are unmistakable evidences of heavy deposits, that only await development in 27 counties, viz: Barry, Barton, Bollinger, Callaway, Christian, Cole, Cooper, Dallas, Dale, Douglas, Gasconade, Greene, Howell, Jefferson, Laclede, Lincoln, Monroe, Newton, Pulaski, Reynolds, St. Clair, Ste. Genevieve, Stoddard, Texas, Wayne, Washington and Webster. There are also indications of iron ores in 16 counties, viz: Boone, Butler, Camden, Clark, McDonald, Montgomery, Oregon, Osage, Pettis, Ray, Ripley, St. Louis, Scott, Stone, Vernon and Wright.

The lead deposits of Missouri hold out to the capitalist a most desirable field for the investment of money, with a certainty of large returns. There is no country of equal area on the globe that possesses one-half the extent and variety in lead deposits that our State can claim. From 60 to 85 per cent. of the ore is pure lead, and in some portions of the State it comes to the very surface of the ground. For a long time the hunters of Missouri have been accustomed to break out these croppings of lead for the manufacture of bullets. There has been no deep lead mining, yet Missouri ranks as the leading lead producing State. What will be her revenue from this branch of industry, when deep shafts shall be sent into the almost solid lake

of pure lead that is known to exist, it is impossible to estimate. Lead has been found in 61 counties of Missouri, of which there are but 27 counties that are being worked, viz: Camden, Christian, Cole, Dallas, Dent, Franklin, Henry, Hickory, Iron, Jasper, Jefferson, Lawrence, McDonald, Madison, Maries, Miller, Moniteau, Morgan, Newton, Perry, Reynolds, St. Francois, Saline, Shannon, Washington, Webster and Wright. The counties in which lead mining is not developed, although it is know to exist in paying quantities, are 14, viz: Barry, Barton, Bollinger, Cooper, Crawford, Douglas, Greene, Howell, Laclede, Ripley, Ste. Genevieve, Texas, Warren and Wayne. There are also strong traces of lead in 20 counties, viz: Benton, Boone, Carroll, Clark, Clay, Dade, Oregon, Osage, Pettis, Phelps, Polk, Pulaski, Ray, Ripley, St. Louis, Schuyler, Scott, Stoddard, Stone and Vernon, but it will necessitate more thorough explorations to tell if in these latter counties lead can be procured in paying quantities. Copper has been found in 19 counties that give promise of yielding profitable results. In several localities it lies at an average of about 15 feet below the surface, the deposits being several feet thick and paying about 50 per cent. of pure copper. Zinc ore is abundant, but until recently it had no commercial value, and thousands of tons of the sulphuret of zinc were thrown away as worthless by the lead miners, who found it an impediment in lead mining. *Tin* ores have been found in large quantities, and so rich in metal that considerable capital has been spent in efforts to mine and reduce them, but as yet without pecuniary success. *Gold* has been found in two or three counties, but has never been profitably worked. Silver has been discovered in regular lodes in five counties, and in small quantities in nearly all the lead mines of the State, in combination with lead. *Cobalt* exists in considerable quantities at Mine La Motte, and it has also been found in one other locality. *Nickel* is worked at Mine La Motte—it is abundant and of good quality. *Antimony* has been discovered in large quantities in Cedar, Ste. Genevieve and other counties. Saltpetre has been found in a number of different localities, but as yet none has been manufactured. Platinum has been reported as existing in Madison county, but nothing has been found to substantiate the assertion. Marble in Missouri is found in numerous and extensive beds, of various shades and qualities, and will become a very important item of the State resources. *Limestone.*—There is a great variety of limestone in all parts of Missouri. *Hydraulic Limes* have been found and tested in numerous localities and found to possess first-class properties. *Sulphate of Baryta* is very abundant in this state. It is largely utilized as a pigment in connection with lead. Kaoline, from which ironstone china is manufactured, has been found in several localities, and worked in one or two. *Clays.*—Potters', brick and fire-clays have been found and worked in numerous parts of the State. *Paints.*—There are several beds of mineral paints in Missouri of the finest qualities. Sandstones are abundant, of various shades and color, that make them readily valuable for architectural purposes. *Granite and Sienite* of numerous qualities occur in this State. The most abundant is the red, cross-

grained granite, which is very beautiful, particularly adapted for massive and strong work in building. *Road Materials.*—Missouri has an abundant supply of street and road materials. Limestone of the hardest and most durable kinds occurring everywhere, while Madison and the adjoining counties produce green stone, trap, sienite and gray granite, which make most excellent block paving. Thus imperfectly, without any desire to exaggerate, we present a general view of the mineral deposits of Missouri, and no argument is needed to convince the candid reader that if the developments of the mineral resources of the State are pushed forward in the future as they have been recently, our great State will rise up in her glory and wear the crown as queen of the empire.

CHEMISTRY.

Remarks upon the Prevention and Extinguishment of Conflagrations, by Theo. S. Case. Read before the Kansas City Academy of Sciences, April 25, 1876.

(REPUBLISHED BY REQUEST.)

In these days of frequent conflagrations and expensive insurance this subject demands the attention and action not only of the scientific man, but also of the prudent and economical house builder and owner; and in treating it I have adopted the plainest and most practical method and terms; believing that a Society like this can make itself fully as useful to and perhaps more popular in the community where it exists by sometimes discussing practical matters than by giving itself up at all times to abstruse investigations and theories.

Taking the heads of the subjects in their natural order, I have divided that of

PREVENTION

as follows, viz:

1. Prevention by the exclusion of oxygen and atmospheric air.
2. Prevention by fire-proof coatings of the combustible materials used in the construction of our buildings.
3. Prevention by rendering such materials themselves essentially incombustible.
4. Prevention by rendering bedding, clothing, scenery of theatres, etc., incombustible.
5. Prevention by mechanical obstructions, such as fire-walls, etc.
6. Prevention by the avoidance of the causes of spontaneous combustion.

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Combustion is defined to be "the rapid and violent oxidation of carbon and hydrogen by the aid of the free oxygen of the atmosphere," *i. e.* all ordinary combustion is dependent upon the presence of oxygen, and cannot continue in its absence.

I. The first practical inference then that we draw is to so construct our buildings as to prevent the free admission and passage of atmospheric air, which contains so large a proportion of oxygen, to and through those inaccessible portions, such as the spaces under floors and within partitions, where fires so frequently originate and whence they spread so rapidly. Almost every person present will recall one or more instances where a destructive fire originated in or was caused by the ignition of the base-board of a room from to the too great proximity of a red-hot stove, the immediate extension of the flames within the lath and plaster partition and their rapid spread throughout the building by means of the upward draught of air between the studding. Now, had the partitions in such cases been of brick, or even lath and plaster rendered solid in any way, the draught could not have existed and the flames would have had no tendency whatever to pass within the partition. While this will be the case no matter what materials may be selected for solidifying purposes, manifestly it will be better to choose those that are least combustible and cheapest; and I know of none cheaper, more effectual and more readily and easily applied than the very same lime and sand mortar which constitutes the first coat of plastering upon such partitions. (So far lime has been found to resist all degrees of heat, not even being volatilized or fused in the hottest blast furnaces, while sand is almost equally incombustible). In an ordinary six inch lath and plaster partition, the studding commonly used is two inches by four, set with the four inch side transversely to the line of the wall. The plasterer, in putting on the mortar, forces it through the interstices of the lath from half to three quarters of an inch on both sides, thus leaving a space of from two and one-half to three inches wide between these keys, as they are called, which gives free passage for the air and flames as before described. Suppose in constructing such partitions, the studding pieces were turned the other way, *i. e.*, with the two-inch side transverse to the line of the wall, then the space between the keys of the mortar would be but from half an inch to one inch in width, which could be very cheaply and easily filled by the plasterer as he progressed with his work, and the partition thus rendered solid, impervious to air and flame, not less substantial than before, not enough heavier to do any harm, far less communicative of sound from room to room, and lastly, permanently obstructive to the passage of vermin of all kinds.

Similarly, the spaces between the floors and ceilings of different rooms could be filled with some cheap material, the more incombustible the better, which would serve the purpose of obstructing the spread of fire, at the same time that it performed the very useful functions of deadening sound and preventing such spaces being used as harbors and thoroughfares for rats and mice. In the Italian and French cities this principle is carefully

observed in the construction of all classes of buildings, and it is very rare indeed that a fire in one of them spreads beyond the room in which it originates, even should the stock of goods or other contents be entirely destroyed.

The same reasoning applies to a considerable extent to the construction of staircases, halls and elevators in public buildings, hotels and dwellings, which, in many cases, become and serve as swift conductors of fire.

Most of you will recall the burning of the Fifth Avenue hotel, in New York, a few years since (and more recently, the Southern hotel, in St. Louis, Missouri), at which times a number of lives were lost and much property destroyed, simply from the fact that the flames of a fire originating in one of the lower stories were drawn, as through a tall flue, up the passage-way of an elevator and through the halls, thus communicating almost simultaneously with the whole six or seven stories and cutting off the sole means of escape for many of the occupants of the house.

No stairway should ascend continuously from bottom to top of tall buildings without being provided with some effective means for cutting off the current of air between the different floors. No hall should extend from end to end or side to side of our large asylums, seminaries or hotels without being furnished with iron doors which, in case of fire, could be easily closed and effectually secured, so as to cut off the draught of air through them, thus checking the rapid spread of the flames and giving the inmates a chance to escape with their lives, if no more. A very small expense, comparatively, for such doors for hallways and for appliances for closing the well-holes of staircases and the hatchways of elevators on each floor, were they nothing more than curtains of some substantial woolen stuff which could be quickly stretched and fastened over the openings, might, in many instances, save costly buildings and preserve valuable human lives. (Since writing the above I am informed that Vassar college is provided with iron doors for the hallways).

The apparent impossibility of rendering buildings absolutely fire-proof has been abundantly demonstrated by the ever memorable conflagrations of Chicago and Boston, where massive structures of iron, granite, marble and brick, upon which immense sums had been expended to render them incombustible, were swept away and consumed almost like straw or paper. This being for the present admitted to be the case, we will turn our attention to such details in the construction of our buildings as will enable them to resist primary ignition under ordinary exposure and sufficiently retard the combustion after ignition to give time for applying the means of extinguishment before the heat is too great to be overcome. Much may be done by the use of iron beams, rafters, joists, floors, lath, roofs and cornices in buildings of stone and brick, but as such buildings can only be erected at great expense, and as it is not to be expected that the use of wood as a building material will ever be abandoned, we will confine ourselves to looking for some method of placing these inflammable materials in the condition

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above described; which brings us to the second point in the consideration of the prevention of conflagrations, viz:

II. The use of fire-proof coatings upon the combustible portions of our buildings.

As you are well aware, the great majority of buildings erected all over the country are at least finished with pine lumber saturated with turpentine and resin, and which is afterward rendered still more inflammable by coverings of paint, composed of oils, turpentine, naptha and other ingredients of like character, while very many are constructed wholly, from roof to foundation, of such materials, and hence offer an attraction rather than any resistance to the flames. It is to this class of structures that my remarks chiefly apply, because they are the most numerous and probably always will be. They belong to a class of citizens who must build cheap houses, and who can least afford to lose them. They contain within themselves all of the essentials and very few of the obstructions to combustion; and finally, they are more liable to communicate the flames to adjoining buildings.

Numerous fire-proof paints have been prepared, and many patented; very few, however, have come into general use, owing in some cases to the fact that they were not preservers of wood as well as protectors against fire, and in others to the fact that they could not be applied in tasteful colors suitable for the inside finish of dwellings and stores. Among those presenting the best indications of accomplishing the objects desired are those composed of "water glass," as it is called, being chemically a silicate of potash or soda in a fluid state, which, being applied as any other paint, gives a hard, fire-proof coating to the wood, and may be tinted or colored with any pigment which is not acted upon by it. Several silicious paints have been proposed, all of which depend for their base upon the "water glass," the other ingredients, such as ochre, clay, steatite, etc., being added only to give body to the mixture. Paints of this kind have effectually protected wooden buildings against fierce flames for twenty to thirty minutes—long enough to give their inmates or the fire department ample time to apply competent means of extinguishment, and showing that no ordinary heat, such as might be thrown out by a red hot stove, a burning curtain, or even a gas burner carelessly pushed against it would be liable to ignite a piece of woodwork covered with them. Other paints are highly recommended, which are composed essentially of biborate of soda or common borax. Mons. Patera recommends a mixture of equal parts of borax and epsom salts. Chloride of zinc, with oxide of zinc and cream of tartar mixed in starch to the proper consistency gives a paint which is regarded as equal in every way to any lead or zinc oil paint, besides rendering wood almost incombustible, which quality is increased by the addition of a small amount of borax. Another coating highly recommended as fire-proof is composed of a mixture of one-third sulphate of ammonia and two-thirds sulphate of zinc; still another is composed of a mixture of sulphate of alumina with sulphate of

iron, clay, etc. A French journal recommends washing the wood-work with a solution of ordinary pearl ash, then applying several coats of the same, thickened with clay and flour paste, after which a composition of glue thickened with iron filings, pulverized brick and ashes; this will resist fire for five hours and prevent the wood from ever bursting into flames, *i. e.*, cause it to so resist the ravages of fire as at most only to be reduced to coals and ashes, without increasing the conflagration by additional flames. Under most circumstances lime mortar is found to resist the spread of the flames about as effectually as any other coating, besides being far cheaper than most of them. A writer in the London *Science Review* for September, 1872, states that after the conflagration of Paris is was generally found that with good plaster-work over them beams and columns of wood were entirely protected from the fires. In cases where limestone walls had been utterly ruined on the outside by the flames, the same wall internally escaped almost unscathed, owing to their being coated with plaster. Stone staircases well protected by plaster were fire-proof.

Thus it will be observed that the alkalies and the alkaline earths possess remarkable fire-proof qualities, and that paints and other coatings composed of them wholly or in part may be depended upon to at least materially retard the progress of the flames in any ordinary case of fire, if not to check them altogether. It will also be noticed as we progress in the discussion of this subject that they figure prominently in nearly all of the proposed means for preventing the spread of the flames in conflagrations.

In the few experiments I myself have made with fire-proof coatings, I have found none superior to those first named, viz: the water gluss compositions, in efficiency and applicability to fine work. I think for use in cheap structures, more especially factories and warehouses where inflammable materials are handled, a mixture of animal glue with ashes and lime or salt will be found much cheaper and nearly as efficient.

Such coatings as these are also especially and imperatively demanded in our steamboats, public halls and theaters, where the otherwise rapid combustion of the light and fanciful wood-work, curtains and scenery endangers human life more than almost any other circumstances.

III. The grand object, however, of all of our investigations in this direction, is the discovery of some means of rendering the substance of the wood itself incombustible. Having accomplished this, we may regard our houses as quite safe, and not before, for as long as it is impossible to exclude the air from them or build them perfectly solid, fires are liable to be kindled and will spread, and no matter with what coatings we may cover the wood-work, long continued and fierce heat will crack them off or penetrate to the inflammable material beneath; but when we can render the wood itself actually fire-proof, at so low a price as to give the benefit of the discovery to all, conflagrations need no longer be feared; for a material of this kind will be found superior to stone, brick and even iron itself in adaptability for building purposes.

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At this point I desire to digress briefly, to point out the advantages which would be possessed by wood rendered incombustible over those materials ordinarily used by persons undertaking to construct fire-proof buildings, viz: stone or iron.

1. Such timbers would be more easily and readily transported, worked, handled and fitted, than either stone or iron.

2. They would not crumble or disintegrate under exposure to heat, as did the granites, sandstones and marbles of Chicago and Boston.

3. They would not expand under similar exposure and overthrow the buildings they were intended to support, as it is the well known tendency of iron columns, beams and joist.

4. They would not at a heat of from 1200° to 1500° F. become soft, as is the case with cast iron when red hot, and liable to yield to a superimposed pressure which it would really support when cold.

5. They would not be cracked or fractured by the application of water to them when hot, as is the fact concerning both stone and iron.

6. They would not under any circumstances tend to ignite spontaneously themselves nor produce the ignition of adjoining inflammable materials, as is believed by scientific men be the case with iron when oxidizing in contact with wood or other combustible substances.

Under none of the circumstances named above will wood which has been rendered fully fire-proof be unfavorably affected, but on the contrary it will resist all of the effects of heat upon stone and iron just given, besides some others of minor importance.

Numerous attempts have been made to achieve this desirable result, but as yet no certain success has been reached. Among the various substances suggested for the purpose are sulphate of iron or copperas, sulphate of lime or gypsum, and various other salts, mostly of the alkalies, with which it is proposed to fill the pores of the wood. That success may be reached in this way there is no reasonable doubt, for even dry gunpowder itself may be prevented from burning by separating its particles by means of almost any incombustible material pulverized and mixed with it, such as earth, sand, powdered glass, etc.; but the difficulty seems to be to find some means of introducing the protecting salts into the wood less expensive and elaborate than any yet proposed.

The present methods are to first prepare the wood by kiln drying, to deprive it of its moisture and volatile oils, then by great pressure force the preservative fluids into the open pores of the wood; or, to exhaust the air, moisture, etc., *in vacuo* and then introduce the salts by atmospheric pressure alone. Still another plan is to displace the fluids in the lumber by columnar pressure, as an apothecary displaces one fluid with another in preparing his tinctures; all of which methods are expensive and troublesome.

An English clergyman, by soaking the wood in a solution of tungstate of soda, succeeded in rendering it completely impervious to fire. The following were some of his experiments: "Two small pyramids of sticks

were made, one of prepared wood and the other of unprepared wood. These were then saturated with paraffine and ignited. In the case of the prepared wood the paraffine soon burned itself out without communicating the flames to the wood, which was only slightly charred. The other heap burned fiercely, and in half an hour was reduced to ashes. The next experiment was made with two wooden huts, one of which had been prepared, while the other, built of ordinary Scotch fir, had not. A strong fire, sufficient to ignite the houses, was made in each, and the effect was the same as in the previous experiment. A chest containing a parchment document, was treated by the process and was thrown into the flames when at their height, and was taken out sometime afterwards, charred indeed on the outside, but uninjured in every other respect. The inside was quite cool, and the wax seals on the document were intact. Perhaps the most important trial was that which took place with gunpowder. A government keg, which had been rendered fire-proof, was used. A paper packet containing two ounces of gunpowder was put in the bottom of the keg, and a sheet of brown paper impregnated with the tungstate was pasted over it and dried. The keg, which was open at the top, was turned upside down and surrounded by shavings, which were lighted. A fire of petroleum and shavings was kept burning on the top fifteen minutes without producing the slightest effect on the keg. To make the trial still more complete, the keg was reversed again, and lighted shavings were thrown upon the gunpowder protected only by a sheet of brown paper. The paper stood the test admirably, and the solution rejected the fire so thoroughly that the paper did not show even a sign of charring. The gunpowder was then taken out and exploded."

Messrs. Moore & Weatherby, of England, have adopted a plan for the impregnation of wood with a fire-proof solution, which combines with the mechanical processes above described, a chemical action involving the formation of the desired salt within the structure of the wood. After kiln-drying the lumber to be acted upon, they put it into suitable cylinders where lime and water with sulphurous acid gas are forced into the pores of the wood under considerable pressure, the theory being that when sulphurous acid is passed into lime under pressure a sulphite of lime is formed which is soluble in water, capable of crystalizing into a bi-sulphite, which is readily oxidizable and convertible into sulphate of lime or gypsum.

Most of the sulphates are to be regarded as incombustible, owing to their firmly resisting oxidation, but sulphate of lime being probably the cheapest and best non-conductor of the heat of any of them, is most used by manufacturers of fire-proof safes and for similar purposes, and hence the effort of Messrs. Moore & Weatherby to produce it. Of course their process is too expensive to be applicable to ordinary building materials; but since the kiln-drying is only requisite for driving off the turpentine and other volatile and inflammable oils, I am not sure that it may not be dispensed with in preparing many of the loose-grained and non-resinous woods used for build-

ing purposes, such as poplar, linn or basswood, cottonwood and elm, and the impregnating process applied directly to them after an ordinary seasoning. Further than this, I am not certain that by first saturating such woods with lime water, and then, after allowing them to dry out again in the open air, subjecting them to a dilute solution of sulphuric acid, the same result, namely—the production of sulphate of lime in the pores of the lumber, would not be arrived at.

Still further, since magnesia resists heat equally well with lime, and has never yet been fused or volatilized under exposure to the highest temperatures, I would suggest that timber or lumber, soaked for a sufficient length of time in a solution of sulphate of magnesia might acquire fire-proof qualities equal to those conferred by saturation with sulphate of lime.

The cheapest method which has yet been proposed for effecting this object is that of utilizing the natural functions of the tree itself for the purpose of effecting a more complete and perfect penetration by the preservative solution, the force of the ascending sap at the proper season of the year being brought into requisition to convey throughout the entire extent of the tree certain silicious and phosphatic solutions which had been introduced either at the amputated base of the trunk by means of its immersion in vessels of the preparation, or through openings made in the living, standing tree with augers or saws. Since it is well known that various coloring agents may be introduced into living trees in this way, it is altogether possible that they may also be impregnated with incombustible salts in the same manner. Within the past few days I have heard a gentleman from Texas describe a grove of standing trees in Fayette county in that state, covering some twelve or fifteen acres, which had been petrified in so perfect a condition that in some instances not only the trunks and larger branches, but even the smaller boughs, remained *in situ*. He also stated that the peculiar appearance of a stick of wood which had fallen from a wagon upon which it was being conveyed to a farm house for fuel, attracted his attention and that upon examination it proved to be partially converted into stone. I can only account for these facts by supposing that the silicification of these trees was produced by the absorption of the mineral through their roots into the pores of the wood while in a soluble condition, the subsequent evaporation of the solvent through their leaves, and the deposition of the solid salt within the substance of the wood, their final death, being possibly from this mechanical obstruction of their sap channels, and their apparent complete conversion into stone by the dropping away of the bark and woody fiber from trunk and limbs in the lapse of time. If such transformations in nature are susceptible of such explanation it seems entirely feasible to imitate them artificially.

My own experiments in this direction have been confined to a few pieces of wood found lying about, and are not as conclusive as is desirable, but at the same time tend to convince me that the means of saturating common building materials with incombustible salts at so inconsiderable a cost as to

place them within the reach of most poor men desiring to build cottages for themselves and their families, are much more ready attainable than has hitherto been supposed.

IV. I deem it perfectly proper and within the legitimate scope of this article to speak of the prevention of fires by the treatment of our inflammable bedding, curtains, and even the clothing of our women and children with certain chemical preparations, which, while they do not ordinarily injure these fabrics, will prevent their readily taking fire, and thus additionally endangering our dwellings and other buildings, and even the lives of ourselves and families.

Among the chemicals whose use is suggested in rendering such articles fire-proof, are common salt, which is highly recommended as being quite effectual and less liable to injure the fabrics than many of the others, alum, borax, tungstate of soda, chloride of zinc, a mixture of tungstate of soda (25 parts), phosphate of soda (3 or 4 parts), and water (100 parts); a mixture of sulphate of ammonia and gypsum; a mixture of alum (3 parts), copperas (1 part), etc. A incombustible starch has also been suggested, composed of a mixture of phosphate of ammonia-magnesia and tungstate of soda in starch; another composed of the cystals resulting from a combination of chloride of calcium and acetate of lime mixed with starch; and still another prepared by mixing an acid solution of the chloride of zinc with starch. These starches applied to the fabrics in the ordinary way have been found very effectual protectors against fire in many instances.

For protecting the scenery of theaters, curtains and other movable hangings, a coating of water glass, with a little glycerine added to prevent its cracking and breaking off, has been highly spoken of.

V. I now come to the consideration of the prevention of fires by mechanical obstructions. These are mainly of service in hindering and preventing the spread of the flames from building to building, and consist chiefly of fire walls and metal roofs, cornices, shutters, etc. Very little can be said about the first, except that they are usually entirely too low to be of much service, my opinion being that no fire wall less than six feet high will afford any reliable and certain protection to an adjoining building. Mr. Vesey recommends in addition to the ordinary fire walls between buildings, the carrying up of walls, between blocks of buildings separated by alleys, to a considerable height above any of the buildings, for the purpose of preventing the spread of conflagrations across such alleys or narrow streets.

Metallic roofs, instead of lying directly—*i. e.*, flat upon the sheathing beneath, should rest upon it only at as remote points as their proper support requires, leaving elsewhere a space of at least two inches between them, to prevent the heat of fires passing through the metal and igniting the wood beneath. I was very much surprised a few years, since to observe how readily I could ignite a pine board, such as is ordinarily used for sheathing by burning a handful of shavings upon a piece of tin roofing placed upon

it. There are several so-called composition roofs, which, in my opinion, are better protectors against fire than metal, because of their superior non-conducting properties.

Wooden cornices are the most dangerous of all fire traps, and should be prohibited in all cities.

Metalic shutters are of the greatest value when closed, but, being usually forgotten until it is too late to close them, they should be so constructed as to shut automatically at the approach of danger. One means proposed for affecting this is to provide them with springs which will force them shut upon the melting of the fusible metal fastenings with which they are to be held open; but as these springs might from long disuse lose their elasticity, or the hinges their mobility, it might be an improvement to have these shutters suspended above the windows by means of catches of fusible metal or some inflammable material. They would then drop of their own weight when the catches were melted or burned by the approaching flames, and be much more likely to assume their proper places than under the circumstances first named.

VI. Before closing this branch of the subject it may be well briefly to consider the subject of spontaneous combustion, so far as it bears upon that of the prevention of conflagrations. That certain substances under certain circumstances will ignite without the application of fire or other obvious cause, is a fact too well established to require proof, but in this connection I shall only have time to point out a few sets of circumstances under which such spontaneous combustion has occurred, and against which we should guard in our dwellings and places of business:

1. Common soft coal containing a considerable proportion of sulphuret of iron (iron pyrites), a very common impurity in all the bituminous coals of this region, is very liable to ignite spontaneously, especially when wet, which demonstrates the danger to be apprehended from the very common practice of sprinkling water upon the coal in our bins and cellars to lay the dust.

2. Matches, when kept in considerable quantities together, are liable to ignite spontaneously, owing to the inflammability and oxidability of the phosphorus contained in them.

3. Solar heat acting upon the bisulphide of carbon, used in all India rubber factories, has been known to produce it. Also it has occurred in warehouses where rubber blankets and clothing were stored. So well known is this fact, that during the late war orders were issued respecting the separate storage of such supplies.

4. Nitric or sulphuric acid thrown carelessly around upon refuse straw, wool or other litter, will frequently ignite them.

5. Cotton rags or almost any other waste saturated with oil, used in lubricating and wiping machinery, have the property of spontaneous combustion in a remarkable degree and have frequently produced serious conflagrations by taking fire in this manner.

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6. Heat enough to communicate fire to adjoining inflammable substances may be generated by the slaking of lime and the rapid fermentation of damp manure, leaves, hay, etc., when piled in large heaps.

7. Freshly burned charcoal is said "to have the property of absorbing moisture, and rapidly condensing it in its pores, generating thereby so much heat that it is set on fire."

7. Several instances have been published by the *American Journal of Science*, one of our most reliable scientific periodicals, of combustion taking place in old heaps of wood ashes that had not been added to or disturbed in any way for months before.

9. It is believed by some of the best chemists that the oxidation of iron rods or pipes passing through or in contact with wood-work has resulted in spontaneous combustion and the ignition of the wood.

10. Several cases of conflagration on land and sea have been reported as caused by the concentration of the sun's rays upon inflammable substances within apartments by means of mirrors or panes of ordinary window glass. Whether these cases can be properly classed among those of spontaneous combustion may be questionable, but the knowledge that fires can be generated in this way may lead to the solution of some very mysterious cases, as well as warn us to avoid the possibility of such contingencies occurring.

11. The national board of underwriters in its late meeting at New York, reported against the use of petroleum as a lubricator on the ground that its use was dangerous and the cause of many fires.

This brings us to the end of my first division of the subject, and I will more briefly take up that of the *extinguishment* of fires or conflagrations under the following heads, viz:

EXTINGUISHMENT.

1. Extinguishment by means of ordinary water.

2. Extinguishment by means of water holding in solution gases which are non-supporters of combustion.

3. Extinguishment by means of such gases applied directly to the flames by machinery.

4. Extinguishment by means of gases or vapors generated by the heating or combustion of certain materials with which the timbers were coated or otherwise protected previously to the erection of the building.

I. Extinguishment by means of water. As it is well known that one of the constituent elements of water is highly combustible, while the other is the essential supporter of combustion, and also since it is a fact that the oxygen is separated from the hydrogen by passing the vapor of water over iron filings heated to redness at about 1500° F, the statements published by some of the Chicago and Boston paper after their great fires, that the vast amount of water thrown upon the burning buildings, by its decomposition and reduction to its gaseous elements, actually fed the flames, had a degree of plausibility about it although probably entirely incorrect.

The action of water upon fires is rather mechanical than chemical, quenching it by "physical contact with the burning body, covering it and excluding the oxygen of the air." Also, "it instantly reduces the temperature of ignited substances by vaporization. By a sudden change from a liquid to a vapor, it robs the substance of the heat necessary to keep the up the combustion and thus extinguishes it."

While owing to its extreme abundance and cheapness in most localities and at most times, water is the most useful and serviceable agent in the extinguishment of fires, yet from the damage done by it, the difficulty of applying it under all circumstances and the immense amount required to subdue an ordinary fire, it will not be surprising if, before another century elapses, it will have been superseded by other agents more effective and less objectionable.

Numerous means have been proposed for rendering its use more effective and its application more immediate and direct than at present, when we depend almost wholly upon our fire departments, and are obliged to await the arrival of the steam fire engine with its terrific floods of water, which, however well directed, seem in many instances to do more damage than would have resulted from the fire if left to itself. Much good will be accomplished by the discovery of some means of applying this agent strictly as an extinguisher, in quantities regulated to the amount of fire, in place of the present plan of applying it in volumes ten if not one hundred times more copious than is requisite, *i. e.* mathematically requisite, for the mere extinguishment of the flames.

One plan proposed for regulating the quantity and force of the water applied to fires is that of stand pipes in factories and warehouses, filled from the water-works or from tanks overhead and running from basement to roof, with appliances of hose and nozzle on each floor, and upon the roof, so that they can be brought to bear instantly at the points where they are required.

Perforated pipes placed along the ceilings of rooms, above the stages of theaters and over those localities in workshops and stores where inflammable materials are exposed and handled, may be found of the greatest use, having the advantage over engines of being always at hand and ready for use, and of applying the water in quantities appropriate to the occasion, just where needed and without unnecessary or injurious violence.

Nelson Carl proposes to carry pipes upon the roofs of buildings, to perform the double purpose of wetting them in case of fire, and thus preventing their ignition, and also of acting as conductors of lightning. Particularly would such contrivances as those described above be found extremely efficacious in very tall buildings, where the water thrown by the engines only falls upon them in spray and is converted into steam or driven away by the heated currents of air.

II. It is very apparent that if we can mix with the water used for extinguishing conflagrations some gas which is itself an extinguisher of flames,

we shall increase the efficiency ot the water and at the same time reduce the quantity required, thus taking at least one step in the direction indicated in the foregoing paragraph.

The principal gases which are soluble in water and also incapable of supporting combustion, are carbonic acid gas and sulphurous acid gas, both of which are readily and cheaply produced and easy of application for the desired purpose. Carbonic acid gas is soluble in water to the extent of about volume for volume, and is so well known as an extinguisher of fire that it has been used somewhat during many years for the suppression of conflagrations, both in the well known "Phillip's Fire Annihilator," a machine in which it was produced, combined with steam generated at the same time and forced upon the flames through pipes, and more recently in the Babcock and other "extinguishers," in which it is generated over cold water which it impregnates and forces rapidly out by its expansion. It is proposed to construct similar machines for the generation of carbonic acid in the basements of factories and business houses, with pipes leading to various portions of the building, by means of which this gaseous water can be speedily prepared and applied directly where it is demanded.

The *English Mechanic*, March, 1871, published a description and illustration of a fire engine on an entirely new principle, which consisted in charging the water used with carbonic acid gas and nitrogen, obtaining the carbonic acid by drawing atmospheric air through a charcoal fire and forcing it into a tank containing water. It is claimed that one cubic foot of this solution is capable of doing as much execution in extinguishing flames as fifty cubic feet of ordinary water, and in one-twentieth of the time. Whether this invention has been brought into practical use I do not know. These machines, or at least this application and use of carbonated water or vapor by *some* machine have the elements of success within them, since one gallon of water saturated with carbonic acid gas is equal in extinguishing power to ten of ordinary water, not to recapitulate the other advantages possessed.

Sulphurous acid gas is soluble to the extent of more than thirty times its volume of water, and is utterly incapable of supporting combustion. Being heavier than carbonic acid gas, as well as less energetic in its evolution, it will not act voluntarily in forcing the impregnated water through pipes, but on account of the greater amount absorbed by the same quantity of water and its equal fire quenching qualities, this defect might be profitably overcome by the use of machinery operated by other forces.

Dr. Clanney's fire extinguishing solution consists of a mixture of chloride of ammonium (sal ammoniac) and water in the proportion of five ounces of the salt to one gallon of water.

III. The next suggestion is that of applying gases and vapors which are non-supporters of combustion directly to burning substances by means of suitable machinery. In many instances this plan is applicable where neither water, nor water saturated with gases, can be used effectually, for

instance under floors or within partitions in buildings, in the holds of vessels and in mines.

The first of these agencies to be considered is steam, which from its almost universal use and ready applicability to such cases, becomes a very important and effective power. Suppose a fire originates in a basement or other underground room from the furnace which is generating the very steam subsequently used for its extinction; it is not readily accessible to firemen with their hose and pipes, neither can it be reached with water from buckets; but with no loss of time whatever a jet of steam can be turned upon it, the doors of the apartment closed, and in a few minutes every corner and cranny will be filled with an overwhelming and certain extinguisher.

In the same manner steamships and steamboats may often be saved from destruction by fires originating in their holds where no amount of water short of enough to sink the vessel will reach them, while by closing the hatches and forcing in steam through pipes connected with the boilers the flames will be very soon subdued and with but little or no damage to the cargo from the extinguishing agent.

It is but a year or two since reports of a terrible fire in a coal mine in Pennsylvania reached us through the newspapers; a fire which raged irrepressibly for several months, doing vast damage. After exhausting all means within their power to quench it, unavailingly, the owners determined to try the effect of steam. The entrance was made as tight as possible and immense quantities of steam forced in, which fortunately resulted in the speedy extinction of the conflagration.

Dr. Weidenbusch, of Wiesbaden, also highly recommends steam as a fire extinguisher, and gives as an illustration of its efficiency the case of a factory in which a fire had been raging unmanageably for two and one-half hours, at which time steam was turned on, and in half an hour the fire was extinguished, although there were no means of confining the steam to any particular locality in the building.

Carbonic acid gas has also been brought into service as an extinguisher under similar circumstances, both on land and on shipboard, sometime mixed with steam, as in "Phillip's Fire Annihilator," sometimes with nitrogen and sometimes alone, but successfully in all cases where the surroundings were favorable. A noted case is that of a coal mine in England, which had been on fire for thirty years, but which was extinguished by the use of this gas within one month after its first introduction.

Sulphurous acid gas may also be rendered very useful in many such cases, and is peculiarly adapted to them from its requiring no special apparatus for its production or application. If a chimney is on fire, a half pound of sulphur or brimstone burned in the fire-place or stove, all openings in the chimney having first been made as tight as possible, will in two minutes extinguish every spark of the fire. If a fire breaks out it the hold of a sailing vessel, the use of steam is of course out of the question, and there may be no means at hand for generating and applying carbonic gas; but any

one can let an iron pot filled with burning brimstone down into the hold, close the hatches and thus extinguish the fire at once. The chemical action in these cases is the absorption or abstraction of the oxygen from the atmosphere by the sulphurous acid gas generated by the burning brimstone and the consequent inability of the residue to support the combustion.

IV. The last suggestion I shall make is the extinguishment of fires by means of vapors or gases generated from the heating or burning of certain materials with which appropriate portions of buildings were coated or otherwise protected previous to their erection. It may seem paradoxical to say that a fire may be made to extinguish itself, but I am not at all certain that it is an impossible thing. Suppose, for instance, that we were to coat the joists under our floors with a mixture of flour of sulphur and glue. When the fire that we will assume to be burning reaches these joists in the confined space between the floor above and the ceiling below, the sulphur will be ignited at once, the fumes of sulphurous acid gas given off copiously, the oxygen of the air absorbed, and the fire extinguished by its own act; and so with any other gaseous non-supporter of combustion that we may conceive to be generated by heat. I have never heard of this idea being put into practice, but I see no reason why it should not succeed.

Steam has also been made to act in this very capacity by being generated, in cases of fire, from vessels of water placed between the outer and inner doors of iron safes and vaults. A remarkable case of this kind was reported in the *Journal of Applied Science* (Boston), which was in brief as follows: Vessels of water were kept not only between the outer and inner doors, but also inside the vault itself, and when the great fire occurred the result was the most perfect protection of its contents imaginable. When the fire approached this vault the heat at the outer door converted the water within into steam, which had the effect to keep the temperature of the interior so low that not only were the papers deposited within not destroyed after several hours' exposure to intense heat, but they were actually unharmed, and the wooden vessels in which the water had been placed were intact. This suggests ideas well worth following out to a greater extent in practice than I am aware of having been done, and I do not doubt that the most important results may be secured by an intelligent and scientific series of experiments in this direction.

This concludes all I have to say to-night. There is a very small proportion of original matter in this paper, but if by gathering these facts and suggestions together from a great number and variety of sources and giving them to you in a condensed form, with some attempt at their arrangement in proper order and sequence, I have either added anything to your stores of information or furnished you something new and practical to think of, I shall have accomplished all that I had in view in preparing it.

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THE ATMOSPHERE IN ITS RELATIONS TO VEGETATION.

Few of our readers need to be told that the greater part of the nutriment of plants is derived from the atmosphere. The fabled food of the chameleon is the real food of the whole vegetable world. It may indeed be asserted that all the constituents of plants, except the ash, are of atmospheric origin. Not that crops draw their supply of nitrogen directly from the air, or perhaps in all cases their entire supply of carbon; but the ammonia, nitric acid, and carbonic acid which they get from the soil are themselves derived from the atmosphere. By nitrogenous manuring we are in fact simply furnishing our crops with nitrogen previously obtained from the air under a different set conditions.

The atmosphere is, however, to a limited extent an original source of food; it merely forms part of a great circle, and is itself supplied with carbon, and partly also with nitrogen, from the exhalations of the earth. The organic parts of plants and animals are resolved by the process of decay into gases, which pass into the atmosphere and are universally diffused for the benefit of growing vegetation. The nature and amount of the various constituents of the atmosphere, and the manner in which they are assimilated by plants and the soil are clearly questions of the highest interest to the student of scientific agriculture.

The atmosphere furnishes our crops an abundant supply of carbon in the form of carbonic acid gas. At Rothamsted, England, wheat crops containing on an average about a ton of carbon to the acre were taken from the land for twenty-thee successive years, though no carbon was returned in the manure, and the experiment might have been continued for an indefinite period with similar results. This vast amount of carbon has certainly been obtained from the atmosphere.

The percentage of carbonic acid present in the air has repeatedly been made the subject of scientific investigation. Herr Schulze at the experimental station at Rostock determined the amount of carbonic acid present each day for three years. The variations observed were not great, the largest quantity of carbonic acid found being 3.44 volumes, and the smallest quantity 2.25 volumes in 10,000 volumes of air, the mean of all his results being 2.92 volumes of carbonic acid in 10,000 of air. This proportion —3 to 4 volumes in 10,000—is the quantity which has most usually been obtained. If we take 3.5 as a mean number, then 1 lb. of carbon will be contained in about 3500 cubic yards of air of the ordinary temperature and pressure. As we have just seen that a good wheat crop is capable of removing one ton of carbon from the air in the course of a few months, it is evident that the constant renewal of the air by winds perfectly compensates for the small fraction of carbon it contains.

The amount of carbonic acid in the air is rather less at the surface of the sea than on land. It is at sea greater in the day than in the night, but

on land the reverse is the case, especially in the neighborhood of vegetation, as recently shown by Truchot. Plants continue to produce carbonic acid in the night as in the day, but in daylight the decomposition of carbonic acid is so great that none is evolved, while in the night evolution takes place. According to Truchot the proportion of carbonic acid in the air diminishes with an increase of altitude, and is less on mountains than in the valleys. This is probably the case, as the carbonic acid of the air is supplied by exhalations from the earth.

Truchot has also made some experiments on the influence of altitude on the amount of ammonia present in the atmosphere. The greatest altitude employed for observation was the summit of the Pic de Sancy, about 6000 feet above the sea. There appeared to be a distinct increase in the amount of ammonia at considerable altitudes, and the quantity was apparently greater in foggy than in clear weather. The largest quantity of ammonia found was 1 lb. in about 107,289 cubic yards, and the smallest amount 1 lb. in 640,262 cubic yards of air.

The ammonia in the air is probably derived entirely from exhalations from the earth, though Schlosing believes that a portion of it emanates from the ocean. The nitrates washed into the sea in vast quantities by rivers are, in his opinion, converted first into food for marine plants, and on the death of these plants, or of the animals feeding on them, a part of the nitrogen is returned to the air as ammonia.

Of nitrous acid the air has undoubtedly an original source in the electric discharges, silent or otherwise, which are continually occurring. It is well known that nitric acid is produced whenever an electric spark passes through the air, and it was supposed that the ozone produced by the spark was capable of oxidizing nitrogen into nitric acid. This property of ozone if established, was clearly of great importance, as ozone is apparently given off in small quantities by plants in sunshine, and vegetation would thus itself afford a supply of combined nitrogen. But according to Carius, who has thoroughly investigated the subject, ozone is quite incapable of oxidizing free nitrogen; it will, however, oxidize ammonia into nitrites and nitrates, and doubtless converts into nitric the nitrous acid produced by electric action.

Another oxidizing substance present in the atmosphere is peroxide of hydrogen. The conditions under which it occurs have been studied to some extent in Germany, but the results as yet obtained are not very definite.

The total amout of combined nitrogen which is brought to the soil annually in the form of rain was determined some years ago at Rothamsted. Bretschneider more recently has given the results of six years' observations at the experimental station of Ida-Marienhutte where the average rainfall is about 22.5 inches. The quantity of combined nitrogen (ammonia and nitric and nitrous acid) contained in the rain, varied during the six years from 6.32 lbs. to 12.61 lbs. per English acre, the average being 9.94 lbs. As we remarked last month, the fertilizing influence of snow is due to the nitro-

gen compounds which it brings down from the atmosphere. According to the experiments made four years ago by Vogel at Munich (briefly referred to in the *Journal* for May, 1873), freshly fallen snow furnished water containing .003 gramme of ammonia to the litre; and snow that had lain twenty-fours on a field which had been manured the previous autumn was found, when melted, to contain .012 gramme to the litre. The whole amount brought down by rain and snow must constitute no insignificant fraction of the nitrogenous food of plants.—*Boston Journal of Chemistry.*

TECHNOLOGY.

PROPERTIES OF IRON AND STEEL CONSTRUCTIONS.*

EXCESS OF ELASTIC LIMIT.

The limit of elasticity is generally defined as that stress per square unit beyond which permanent changes of form occur, while under less stresses the body returns to its former condition. Reference is made, not to sudden changes in stress and shocks, but to gradually increasing strains. But the definition is theoretically worthless, for a limit so definite is not probable, and much less is it proven. On the contrary, Hodgkinson and Clark have observed that there are permanent changes of form under very small loads. At present we must be content with defining this limit with Fairbairn, as that stress below which the changes in form are approximately proportional to the forces, while above this they increase much more rapidly. The words "approximately" and "much" are not so indeterminate as might be supposed, for in the experiments of Bauschinger, the passage beyond the limit of elasticity could be determined very precisely; as for example in tension; "for with the same increase of load a disproportionately great elongation occurred at once, the maximum of which was in every case reached after some time." This sudden elongation must be credited to permanent changes of form; further elongations until near the breaking limit remain proportional to the stresses, and the modulus of elasticity is always found to be independent of the latter. In the first definition the changes of form which are permanent from Bauschinger's point of view are neglected. All experiments, up the present time, have shown that when the elastic limit is passed, the tensile resistance is considerably increased, while ductility and tenacity diminish; the metal becoming brittle, and having little power of resistance to shock. In experiments at the Woolwich Arsenal, an iron rod, four times ruptured by pull, gave the successive values of

*From Weyrauch's Work on the Strength and Calculation of Dimensions of Iron and Steel Constructions. D. Van Nostrand, New York.

t: 3,520, 3,803, 3,978, 4,186; Bauschinger tore apart a piece of iron seven times, and the resistance increased from 3,200 to 4,400.

Paget found that iron chains after stretching bore a greater dead weight but had less resistance to shock. Fairbairn thought all these phenomena could be explained by the hypothesis that the resistance of all the parts was not at first called into action, but, like ropes, they became gradually strained in common under sufficient load. With this accords the fact that Bauschinger observed that increase of resistance, especially in rolled iron, was notably regular when the stress was in the direction of the fibres. The analogy holds further; for a rope, when tense is more easily broken by shock. And this explains why a rod under sudden increase of stress breaks more readily than in case of gradually increasing pull.

When the limit of elasticity is passed, this limit is again raised. Tresca, in tests of rails, succeeded in pushing the limit of elasticity to near the limit of rupture, so that it was less by about one-tenth. The practice hitherto has been to assume as permissible stress (*b*) a fraction of the elastic limit. In this case *b* increases with the number of loads. But the material becomes more brittle, and less resistant to shock, and local passages beyond elastic limits are not excluded. So that we need not assent to the often-advocated opinion that a test of material beyond the elastic limit would be of advantage. It is worth mention that the increase of resistance with the passage beyond each limit cannot go on indefinitely; but a diminution must occur at some time, unless we assume that with very gradual increase of stresses and longer intervals, the original resistance becomes greater than the initial ultimate strength.

Now, if passage beyond the elastic limit can work unfavorably, it should not be permitted. But it is enough to know that, according to the numerous experiments of Styffe and others upon all sorts of iron and steel, the ratio of elastic limit to ultimate strength generally lies between $\frac{1}{1.4}$ and $\frac{1}{1.8}$, and under the most favorable circumstances seldom reaches $\frac{1}{2}$.

Wertheim and Styffe have attempted to establish more precise definitions of the elastic limit, but as they are not better, either theoretically or practically, than others, it would be superfluous to consider them. It is since the time of Hodgkinson and Clard that an empirical importance has attached to this limit; and it is still very narrow in its scope, because the limit, as above defined, is of no avail in case of sudden change of strain and of repeated stresses.

Vicat made experiments to determine the effect of lapse of time upon a dead load. He kept wires loaded up to three-fourths the tensile resistance, during thirty-three months. The one with heaviest load broke. Vicat inferred from this, and because the extension seemed to be proportional to the time, that every load beyond the elastic limit would, after lapse of time, cause rupture. Considering that very small loads cause permanent changes in form, it would be more correct to infer that any load, if given time enough, will cause rupture. Fairbairn thought he could prove this by tests

on cast-iron girders. But we do not find that the results of his experiments warrant his conclusion. But the fact that under stress beyond the elastic limit the ultimate strength increases, leads to the the conclusion that security against dead-load increases with time. But if it is objected that a decrease may follow an increase of ultimate strength, it must be admitted, in view of all that has been said, that the influence of duration of dead-load has not been clearly determined. That each load requires a certain time to cause its correspondent permanent change has been known since the time of Hodgkinson and Wertheim, and also accords with Fairbairn's comparison with ropes; and, again, it has been observed by Bauschinger. This also holds true for further changes in form; and if a rod stretched again when released, does not at once return to its previous condition, a so-called secondary action takes place. This was observed in Kupffer's experiments. Thurston thinks that in this he has discovered a new phenomenon; that ultimate strength and elastic limit increase after a strain greater than the latter, continued for twenty-four hours. But there is nothing new in it. That the tensile resistance of iron and steel is greater under the action of an electric current, and that the ductility is effected, now one way, now another, by dipping the metal in acid, seem to be shown by detached experiments, but this needs confirmation.

INFLUENCE OF TEMPERATURE.

The influence of different temperatures upon the strength of steel and iron is not satisfactorily explained. With respect to ultimate resistance only, because of numerous experiments, has their been a growing accord of views. For most kinds of metal, especially for iron, the ultimate strength appears to increase with the decrease of temperature below zero, but also to reach a maximum at a little above 100° C. Within a certain interval near 16° the resistance is quite constant; the beginning and the rapidity of the increase and the position of the maximum are dependent upon the conditions already considered.

Fairbairn, in tension experiments with bar iron, found, in one case, the resistance at 0° equal to, in another, 1 per cent. higher than at 60°. Thurston found in torsion experiments a decided increase of strength to — 12°. Spence, in experiments in bending cast-iron, found at — 18°, a strength greater by about 3.5 per cent. than at + 15°. At higher temperatures, Fairbairn found for bolt iron the maximum of ultimate tensile strength at 163° 41 per cent. greater than at 18°; later experiments with bar iron put the maximum at 213°. A commission of the Franklin Institute, at Philadelphia, found the maximum strength 15 per cent. greater than its ordinary value at about 288°. Styffe has published the results of numerous experiments. See his Table VII.

Beyond the maximum the ultimate resistance decreases at first slowly, but very rapidly at red-heat. In this respect, too, the different kinds of metal behave very differently, and the diminution may possibly be the

quicker and more rapid the lower the temperature of the metal when under mechanical treatment. Tensile resistance Fairbairn found to diminish from 202°, where it was about the same as at ordinary temperature, a low red heat, by about 17 per cent.; up to ordinary red heat, by about 34 per cent. Experiments at the Franklin Institute found the ultimate tensile resistance, at 575° lowered by 0.66, and at 700° by 0.33 from the ordinary value. Bauschinger observed the strength of puddled plate, transverse to the direction of rolling, to be at red heat 780 kil. (2,700 ordinary), and of rolled iron along the fibres, 50 (4,430 ordinary).

These results are of importance with respect to constructions exposed to fire. Kirchweiger, of Hanover, regards the diminution of tensile strength by heating as the cause of boiler explosions; attempting to prove at the same time that a boiler filled with water may become red-hot. Bauschinger thinks it possible that the continual variations and differences of temperature of the outer and inner surfaces may diminish the cohesion of the laminæ of the plate; the inner laminæ bearing a disproportionate share of the strain, and the shearing resistance being lessened.

A frequent theme of discussion is the influence of cold upon resistance to sudden changes of stress—shocks in particular. It cannot be denied that more axles and wheels break in winter than in summer. Styffe maintains that rupture is often due to the fact that the parts are held fast, and, therefore, cannot yield to the contracting influence of the cold: again, for tires, axles and rails, the effect of shocks is increased by the diminished elasticity of the ground.

Sandberg, in an appendix to the English translation of Styffe's work, maintains that these are not the principal causes of breaking. He laid iron rails upon granite supports which lay upon granite rocks, so that the elasticity of the foundations might be the same in any season. The two halves of these rails were tested by blows with a 380 kil. ball at — 12° in winter, and + 29° in summer; and it was found that at — 12° the rail could withstand only $\frac{11}{39}$ of what it could at + 29°. This showed, at least, that there are some kinds of iron that are weakened by frost. Styffe had tested only under dead loads, and in this respect his results were trustworthy.

Sandberg also found this peculiar result: that Aberdare rails, which bore in summer 20 per cent. more strain than those from Creusot, in winter had 30 per cent. less strength. This could be explained on the hypothesis of a difference in constitution which affected the strength unequally. Fairbairn had already shown the unfavorable effect of phosphorus and sulphur at low temperature; and Sandberg thought it possible that different results would have been reached had the metal been free from phosphorus.

Unfortunately the chemical constitution of the rails was not determined; but it seems likely, that phosphorus, which always diminishes resistance to shock, may operate more actively at a low temperature. Its effect also increases under high heat. Styffe found that the grain of a screw-bolt of phosphor-iron was so affected, that a single blow of the hammer broke it.

XUM

Steel, with increasing mixture of phosphorus, loses its capacity to undergo repeated heating without losing its peculiar properties.

In the year 1871, Joule, Fairbairn, Spence and Brockbank contributed to the Manchester Literary and Scientific Society four papers upon the influence of cold upon iron and steel. All agreed that resistance to dead load was not diminished by cold, but considerably increased. Brockbank held it certain that cold diminishes resistance to shock; this, Joule and Fairbairn did not admit. All referred to experiments. No one will question the exactness of Joule's tests; but the test-pieces were wires, needles and nails, so that the results may not hold for larger pieces; while Fairbairn and Spence tested only under dead load. A series of observations by Brockbank confirm the results obtained by Sandberg. Rails were tested with blows; and in frosty weather they had far less strength than at ordinary temperature: a hollow cast-iron core-rod, about which a cylinder had been cast, cooled down to — 7½°, broke square and smooth, leaving a brittle-looking surface, while the pieces were made stiff and sound again by heating. A rod of round iron of best quality, of 38 mm. diameter, which lay a week exposed to frost and was covered with ice, broke at 4½° under a single blow of a hammer weighing 5.4 kil.

All authorities admit the increase of resistance to tension under great cold, though they deny that there is a diminution of power to resist shocks. This is bad reasoning. It is certain that resistance to dead load is somewhat increased by frost; and besides this, according to Styffe, the elastic limit; just as is the case under hammering, rolling, hardening, etc.; but as with all the latter, resistance to shock increases, there seems to be no reason for a contrary judgment in the first case. Styffe has proved that iron becomes stiffer with decrease of temperature; agreeing with Sandberg.

Thurston concludes from results of his experiments that phosphorus and other substances, inducing cold brittleness, may impair resistance to shock at low temperatures, which seldom occur; and that in other cases resistance to dead load, as well as to shock, is increased by cold. This would be novel, but it must first be proven. Thurston's test-machine is well adapted to the lecture-room, being convenient and cheap; but it is not suitable for scientific experiments requiring results numerically exact. The velocity, an important element, is not regulated; the methods of measurement are much too primitive to answer to small differences due to temperature; and it is not to be taken for granted that torsion-tests are best suited to determine the properties of resistance of fibrous and laminated metals.

In a report of the Massachusetts Railroad Commissioners (1874) mentioned by Thurston, it is said, that "cold does not make iron and steel brittle and unsuitable for mechanical purposes, and that it is not the invariable rule that the most breakings occur on the coldest days." The membership of the Commission is not given, nor is it certain what kinds of metal were under consideration. Did it contain a large percentage of phosphorus? Were the rails iron or steel? It has been found in Northern climates

—Canada, Sweden, and Russia—that a low steel, with $\frac{1}{3}$ to $\frac{1}{2}$ per cent. phosphorus, was affected by cold much less than iron. According to Styffe, there is no authentic case in which good steel contained more than 0.04 per cent. of phosphorus; though in one English iron rail there was 0.25 per cent., and in Dudley iron 0.35.

We draw the following conclusions from all the data at hand: (*a.*) Iron and steel, which are entirely or nearly free from all foreign materials, have neither their resistance to dead load notably increased by cold, nor their resistance to shock diminished. (*b.*) Certain elements, not exactly determined, but phosphorus certainly, very much diminish resistance to shock and sudden change of stress. (*c.*) The question cannot be definitely settled until the chemical constitution is determined. (*d.*) Statistics of results in warm and cold latitudes, in summer and winter, after long frost, on days of sudden intensity of cold, are required.

The above has reference to the immediate influence of temperature. In regard to the effect of repeated changes of temperature, Wohler conjectures that frequent vibrations of molecules caused by heat, have the same effect in destroying cohesion as vibrations caused by external forces. Data from observation have not been obtained. Spangenberg, after examination of the fracture surface, did not adopt this hypothesis. Bauschinger, after testing boiler-iron, thought it possible that the strength of the plate was weakened by long action of the fire. But this decides nothing as to the effect of repeated influences. If Wohler's hypothesis is correct, we should recognize in change of temperature a cause of destruction, not only of metals, but also of all other solid bodies. And safety co-efficients would be of no avail, for if we should make one beam twice as large as another, each half of the first would be as much affected as the whole of the second. In any case, bridges and buildings, which are subjected to only slight variations in temperature, will certainly be more likely to fail from other causes.

PAVING COMPOSITIONS.

L. W. Sinsabaugh, of the United States Patent Office, has compiled a most excellent digest of all patents granted for paving and roofing compositions up to January 1, 1876.

Scarce a week passes that inquiry is not made of us concerning some new method of forming asphalt paving composition. For information of such, we will republish the English and American patents granted for such compounds for 1874-5.

Richardson, James P.; March 30, 1875; No. 161,550. Application filed August 1, 1874.—Five pounds copal-gum, 20 pounds asphaltum, and 40 gallons coal-tar are thoroughly mixed and commingled by the aid of heat, and when properly combined, broken stone, ashes, or equivalent material is added to form a plastic mass. This is applied to the road while still hot, and rolled heavily until perfectly solid.

XUM

Claim: The composition of copal-gum, asphaltum, and coal-tar, alone mixed with crushed stone, ashes, or equivalent material, for the formation of pavements, carriage-ways, and the like, as herein described.

Stow, Henry M.; October 11, 1875; No. 168,805; application filed July 20, 1875.—Hard pressed bricks (previously saturated with a composition of 90 parts coal-tar pitch, 4 parts kerosene or dead-oil, 4 parts unslaked lime, and two parts sulphur), are laid in such a manner, either on their sides, edges, or ends, as to leave interstices. The interstices are filled and the entire surface covered with broken stone, gravel, or sand, well saturated with pitch, and heavily rolled. On this foundation is spread a composition of 85 parts coal-tar pitch, 3 parts dead oil or coal-tar, 8 parts unslaked lime, 4 parts sulphur, and sufficient clean sharp sand to bring it to consistency or mortar.

Claim: 1. A pavement composed of hard-burned bricks placed on an earth foundation, with intervening spaces, cells, or recesses for the top dressing to bed into and thereby firmly unite with the brick substructure, and so prevent peeling off, as described and represented.

2. In a pavement having a hard brick foundation, laid with intervening spaces, cells, or recesses, a concrete top-dressing composed of coal-tar pitch, dead-oil, or coal-tar, unslaked lime, sulphur, and broken stone, gravel, or sand, prepared and applied substantially as herein described and represented. [Drawing.]

Thormann, J. H. and Brumshagen, F.; August 10, 1875; No. 166,486; application filed July 22, 1875.—This invention relates to that class of concrete pavements or floors which are laid in sections in imitation of stone flagging, and consists in cementing the sections together with white lead.

Claim: A pavement or floor composed of concrete flags or blocks, separated by interposed layers of white lead, substantially as and for the purpose specified. [Drawing.]

Tucker, J. C.; November 16, 1875; No. 170,132; application filed June 11, 1875.—Artificial stone. This invention relates to certain improvements on that class of artificial stones described in his patent No. 128,680 and reissue No. 5,043.

The present improvement consists in a compound of 70 parts iron-slag, 20 parts asphaltum or other bituminous material, and 10 parts animal, vegetable, or mineral fibre.

Claim: An artificial stone produced by combining slag with asphaltum or other bituminous material while in a heated state, and with an animal, vegetable, or mineral fibrous material, in sheet or block, with or without pressure, substantially as set forth.

Von Versen, F. and Bickel, John; July 20, 1875; No. 165,896; application filed June 24, 1875.—Paving blocks are made of a composition of 25 parts protoxide of iron, 50 parts ferruginous silica, and 25 parts pulverized quartz. The compound is properly tempered with water, and molded into blocks having longitudinal grooves on their edges to receive the cement for

uniting them. The blocks are burned in a kiln until their surfaces are vitrified.

Claim: A paving block or tile composed of the ingredients hereinbefore stated, and burned until a vitreous surface is produced, with or without the grooves *a* and channels *b* or either of them.—*Mines, Metals and Manufactures.*

METEOROLOGY.

THE CAUSE OF MIRAGE.

Mirage (pronounced Me-razhe) is derived from the Latin *miror*, a looking glass. It is the optical phenomenon by which objects are seen as if reflected from a mirror or appear suspended in the air. Sometimes the figures of objects seen suspended are inverted. The facts plainly indicate that in some way the atmosphere, when this phenomenon occurs, is in such a physical condition that it acts like a mirror. What is the cause that produces at times this physical condition in the atmosphere?

I have compared the dates of several hundred cases of this phenomenon with the local condition of the atmosphere where the case has occurred, and find that fully ninety per cent. of the phenomena occur under a high barometer, and the remainder, not exceeding ten per cent., under a low barometer. Not only is this the case, but the phenomenon invariably occurs when there is a calm, or at most only so light a breeze as to be scarcely perceptible. The calms indicate that the phenomenon occurs at or near the centres of both high and low barometers. An inspection of the daily maps of the Signal Service shows, that either a high or low barometer is central, or nearly so, over the locality where the phenomenon occurs. These facts at once point out the direction in which we must look for the explanation of the phenomena.

Those who have carefully read what I have written in elucidation of the fundamental principles of meteorology, know that I hold high and low barometers are electric phenomena. In short, I hold that every centre of both high and low barometers is a highly charged electric point on the surface of the earth; the point negatively electrified under the high barometer by induction acting upon and by attraction pulling down the positively electrified air in the clear sky—characteristic of high barometers—and the electric point in the centre of low barometer, being acted upon by induction from the overhanging positively electrified cloud—for a cloudy sky characterizes the low barometer—sends up negatively electrified air and vapor

XUM

to the positive cloud. Hence in both instances high electric tension, or as it is called, electric potentiality, prevails on every area of the earth's surface covered centrally by either a high or low barometer. A careful consideration of these facts at once suggests whether the electric condition of the air in contact with and immediately over the intense electric point, is not the cause both of the reflection of light where the objects are mirrored on the sky, and of the aberration of light where objects below the horizon loom up so as to seem above it.

The mutual correlation, equivalence, and identity of the physical forces, are well established, and with well-informed scientists are admitted facts. But our knowledge as regards the behavior towards each other and the action between these forces is yet imperfect and in its infancy; but as far as experiments have been made and observation has extended, the results show that there is a mutual action and reaction between them; and that one force will cause the influence of another to deviate from a straight line, and forces it, measurably at least. to avoid collision between them.

For illustration I might refer to the action of crystals as regard light. Crystals unquestionably are formed by electric action, the atoms of which they are composed arranging themselves under the influence of opposite polar forces. It is found that light is more readily and with less aberration transmitted at right angles to the axis of crystalization than along this axis. When a crystal is suspended over a helix carrying an electric current, it will place itself with the axis of crystalization longitudinally to the helix, that is, across the coils of the helix, pointing in the direction that the helix throws its magnetic force. If it be suspended over a straight wire carrying such a current, it will place itself equatorially across the current, that is, at right angles to it, again pointing in the direction the current throws its magnetic force. These facts show that the crystal is affected by polar forces exerting influences in opposite directions, and that light is less obstructed and less interfered with when it is transmitted at right angles to the line along which these forces act, than along with or parallel to that line.

Herr Wiedmann's experiments show that crystals have greater conductibility of electricity perpendicular to their axes than along those axes. Electric currents always develop Magnetism at right angles to the course of the current. For illustration: suppose we draw figures of two circles, and arrows along the line of the first circle showing that an electric current flows along the circumference of the circle in the same direction that we see the hands of a watch move when its face is turned towards us. Arrows are likewise drawn around the second circle so as to show that the current flows in the direction opposite to the movement of the hands of a watch when its face is turned towards us. The electric current circulating in the first figure will develop *boreal* or northern magnetism on the side we are standing; and that of the second circle *austral* or southern magnetism on the same side. In other words, when the progress of a circulating cur-

rent as we see it, is *direct*, that is, with the hands of a watch, then we are said to be standing on its front, and a current always develops boreal magnetism in its front. When the progress of an electric current is *retrograde*, that is, contrary to the hands of a watch, then we are standing in its rear, and an electric current always developes austral magnetism in its rear. Hence the current of our first circle develops boreal magnetism in its front, which is turned toward us, and austral magnetism in its rear, which is turned away from us; and the second figure develops boreal magnetism in its front, which is turned away from us, and austral magnetism in its rear, which is turned towards us. To fix these laws indelibly upon the mind, we have only to remember that electric currents are always flowing from east to west through the *strata* of the earth. Suppose we could see these currents, and that we stood off in space opposite to the north pole of the earth, the flow of the currents would be seen to be direct: hence boreal magnetism is developed at the north pole. At a similar position opposite the south pole, the movements of the currents would be seen to be retrograde: hence austral magnetism is developed at the south pole.

Suppose now that we join our two circles with first figure on top, they will form the figure 8. If we now commence on the left side of the lower loop of the figure 8, and trace the current through and around the entire figure, we find that the current now is continuous; but its course is direct in the upper loop and retrograde in the lower. If these joint figures represent two atoms, then we have the north pole of one atom superimposed over the south pole of the other on the side facing us, and the same on the reversed side, or the side turned away from us.

This forms a magnetic equilibrium the same as two magnetic needles similarly arranged form what is called an astatic needle, a needle that is not affected by the earth's magnetism. This is supposed to be the principle upon which the atoms arrange themselves in the act of crystalization along a line called the axis of the crystal. Hence the season is evident why an electric current will more readily pass through the crystal at right angles to the axis than along said axis.

Magnetism is not a primitive physical force, but is an attribute of electricity. It is an electric effect, and is caused in the following manner. If we subject an astatic needle to the influence of a powerful electric current, then the astatic condition is broken up and the ends of the different needles separate and swing around so that the north poles are together and the south poles also. Or if not, then the astatic condition is destroyed, for the needle which has its north pole on the side of a helical current where austral magnetism is generated, will have its boreal magnetism obliterated and replaced by austral, and *vice versa*. In fact it is supposed that the whole is affected by an atomic change of position, that is, the north poles of the atoms swing around so that they all face one way, and consequently all south poles of the atoms face in the opposite direction.

Soft iron when placed within the coils of a helix becomes instantly an

electro-magnet, and as instantly loses all traces of magnetism when the current is broken. It is supposed that in soft iron the atoms swing easily and hence the instant conversion and reversion that is observed. In steel, which is hard iron, because carbonized and hence compound, the atoms swing only gradually and that by coercion; hence though steel takes on the magnetic influence slowly, yet the magnetism persists after the current ceases to flow, and the steel bar or needle, as may be, remains a permanent magnet.

A ray of polarized light passing through a transparent medium, is deflected to the right or left of its plane of polarization according as the transparent medium is under the influence of the north or south pole of a magnet. A polarized heat ray passing through a crystal of rock salt is deflected from its plane as by the action of the poles of a magnet.

These cases, we think, justify the inference that light will be similarly acted upon by any transparent electrified medium. Magnetism is an effect of electricity, and certainly it is entirely logical to infer that if electricity causes this deviation of light mediately by the indirect action of magnetism, then it can and does cause it immediately by direct action. Air is a transparent, or rather translucent medium. That in calm air or nearly so, under a high barometer, the atoms of oxygen and nitrogen have greatest positive electric tension; and greatest negative electric tension under a low barometer, are facts well established by observation. Deviation of the rays of light from a straight line, causes the phenomenon of mirage; since experiment proves that electric *media* cause such deviation, hence it must be inferred that the abnormal electric tension of the atmosphere—characteristic of the centres both of high and low barometers—causes the deviation of light that produces the phenomenon of mirage, that is, causing objects to appear above the horizon when they are actually below it.

At other times the atmosphere acts like a mirror, giving rise to two species of phenomena: (1) where objects below the atmosphere and beyond the stratum of atmosphere reflecting them are represented as inverted: and (2) where the objects on the same side as the observer are reflected back as if the atmosphere were a mirror.

Fremont, in his journals of his expeditions in the Rocky Mountains, gives an example of this reflection. One day, while in the Utah Basin, they observed a party approaching some miles distant, moving as though they designed to cut off Fremont and his party. The latter halted, and instantly the phantom party halted also. Fremont now detailed one of his party to interview the opposite party, to ascertain what they wanted. Instantly one of the opposite party also came forward to meet the envoy. Then the true state of the case was first perceived, that is, that the suspicious party with such sinister movements was no other than their own images reflected as in a mirror.

On the 29th of March, 1874, I saw a similar phenomenon at Boulder City, Colorado. The day before a heavy snow storm had prevailed, and

snow to the depth of about ten inches had fallen. But on the day in question the air was calm and the sky serene, with a brilliant and warm sun. I was to dine with the Mayor, Mr. Ephraim Pound, but in making calls upon friends noon found me at the base of the mountains; and since Mr. Pound lived in the eastern part of the city, I faced about towards the east, but with bewilderment and astonishment I there saw not only the "foot hills" of the mountains, but mountain ridge rising after and above mountain ridge, until finally the whole was surmounted by the Snowy Range. At first the image seemed near, rising from the eastern limits of the town, but it soon receded and became fainter. When I reached Mr. Pound's, it was, apparently eastward of that remarkable basaltic bute called Valmont. I called the household to come and look at it, but it rapidly vanished, appearing towards the last like a line of faint cumulus clouds stretched along the margin of the eastern horizon.

On several occasions, while in deep mountain canyons, I saw portions of the Snowy Range, with all the intervening mountains mirrored on the eastern sky, when the canyon walls cut off all view of mountains at the point where I was.— *American Meteorologist*, March, 1877.

ICE AT THE BOTTOM OF THE SEA.

Professor Hind, of St. John, N. B., in a recent paper addressed to his government gives a description of the remarkable effect of "anchor ice" on the coast of New Foundland. It is thus summarized by a correspondent of the Toronto *Globe:* Anchor ice is a form of ice which occurs both in fresh and sea water, and is known to the Germans under the name of "Grundeis," to the French Canadians under that of "frazoo," and to the old sedentary seal hunters under the name of "lolly." Anchor ice forms in rapid rivers, and has not unfrequently been described. It is, however, on the borders of the Arctic current, where sea water rapidly cools in the fall of the year, along our coasts that anchor ice manifests itself in a peculiar manner.

During the first cold snap, at the beginning of winter, say towards the middle of November and early in December, the sedentary sealers often had small spiculæ, or needles of ice, formed on the corks of their seal nets, which are set in eight, ten, and sometimes fifteen fathoms of water. If the seal nets are not soon taken up when the corks near the bottom begin to show ice needles forming about them they are liable to be lost. The spiculæ accumulate very rapidly, and, being lighter than water, they will enable the corks to raise the whole net to the surface, and if the anchors are not "frozen to the bottom of the sea" the net is liable to be drifted away by the tides. It sometimes happens that the anchors of seal nets are frozen to the bottom, and when forcibly detached they bring up masses of frozen sand, and this from a depth of fifty and sometimes seventy feet below the bottom of the sea; in other words, the "bottom of the sea is frozen."

XUM

This remarkable phenomena was inexplicable till Despretz showed that sea water in cooling does not follow the ordinary law which governs fresh water when it cools from forty degrees to the freezing point. But sea water increases in density regularly as it cools, hence the coldest water is always at the bottom. Sea water freezes at twenty-seven degrees Fahrenheit, or five below the freezing point of water; hence, as the coastal waters cool in the fall on the Labrador and northeast Newfoundland shores the bottom layer of water acquires, during a cold snap, a temperature of five degrees below the freezing point of fresh water, and from every rough surface, such as stones, bits of sand, seal net corks, seal nets themselves, minute spiculæ of ice form, first at and near the bottom, where the water is coldest, and these very rapidly accumulate, break off and rise to the surface, forming the "lolly." When sealers see "lolly" forming they at once take up their seal nets; and it often happens on the Labrador coast that seals taken in nets sunk fifty feet below the surface are found frozen solid when brought to the surface.—*Journal of Applied Science.*

METEOROLOGY AND SUN SPOTS.—In a report by a committee of the British Association we find the following: "Recent investigations have increased the probability of a physical connection between the condition of the sun's surface and the meteorology and magnetism of our globe.

"In the first place, we have the observations of Sir E. Sabine, which seem to indicate a connection between sun-spots and magnetic disturbances, inasmuch as both phenomena are periodical, and have their maxima and minima at the same times.

"On the other hand, the researches of Messrs. Baxendell and Meldrum appear to indicate a relation between the wind-currents of the earth and its magnetism, and also between the earth's wind-currents and the state of the sun's surface.

"In the last place, the researches of Messrs. De la Rue, Stewart, and Loewy, appear to indicate a connection between the behavior of sun-spots and the position of the more prominent planets of our system. Whatever be the probability of the conclusions derived from these various researches, they at least show the wisdom of studying together in the future these various branches of science."—*Scribner.*

MEDICAL.

MEDICAL PROFESSION IN MODERN THOUGHT.

You will not be long in practice before you will have many occasions to take notice how little people ever think of the power which they have over their own destiny and over the destiny of those who spring from them—how amazingly reckless they show themselves in that respect. They have continually before their eyes the fact that by care and attention the most important modifications may be produced in the constitution and character of the animals over which they have dominion—that by selective breeding an animal may almost be transformed in the course of generations; they perceive the striking contrast between the low savage with whom they shrink almost from confessing kinship and the best specimens of civilized culture, and know well that such as he is now, such were their ancestors at one time; they may easily, if they will, discover examples which show that by ill living peoples may degenerate until they revert to a degraded state of barbarism, disclosing their former greatness only in the magnitude of their moral ruins; and yet, seeing these things, they never seriously take account of them, and apply to themselves the lessons which lie on the surface. They behave in relation to the occult laws which govern human evolution very much as primeval savages behaved in relation to the laws of physical nature of which they were entirely ignorant—are content with superstitions where they should strive to get understanding, and put up prayers where they should exert intelligent will. They act altogether as if the responsibility for human progress upon earth belonged entirely to higher powers, and not at all to themselves. How much keener sense of responsibility and stronger sentiment of duty they would have if they only conceived vividly the eternity of action, good or ill; if they realized that under the reign of law on earth sin and error are inexorably avenged, as virtue is vindicated, in its consequences; if they could be brought to feel heartily that they are actually determining by their conduct in their generation what shall be predetermined in the constitution of the generation after them! For assuredly the circumstances of one generation make much of the fate of the next.

In the department of medical practice in which my work mainly lies I have this amazing recklessness strongly impressed upon me; for it occurs to me, from time to time, to be consulted about the propriety of marriage by persons who have themselves suffered from insanity, or whose families are strongly tainted with insanity. You will not be surprised to hear, I dare say, that I don't think any one who consults me under such circumstances ever takes my advice except when it happens to accord with his inclination. The anxious inquirer comes to get, if he can, the opinion which he wishes for,

and, if he does not get that, he goes away sorrowful, and does just what his feelings prompt—that is gets married when he has fallen in love, persuading himself that Nature will somehow make an exception to inexorable law in his favor, or that his love is sufficient justification of a union in scorn of consequences. Certainly, I have never met with so extreme a case as I chanced to light upon in a book a short time ago. "I actually know a man," says the author, "who is so deeply interested in the doctrine of crossing that every hour of his life is devoted to the improvement of a race of bantam fowls and curious pigeons, and who yet married a mad woman, whom he confines in a garret, and by whom he has insane progeny." But I have met with many instances which prove how little people are disposed to look beyond their immediate gratification in the matter. If it were put to two persons passionately in love with one another that they would have children, one of whom would certainly die prematurely of consumption, another become insane, and a third, perhaps, commit suicide, or end his days in workhouse or jail, I am afraid that in three cases out of four they would not practise self-denial and prevent so great calamities, but self-gratification, and vaguely trust "the universal plan will all protect!"

Those who pay no regard in marriage to the evils which they bring upon their children, or in their lives to the sins by which the curse of a bad inheritance is visited upon them, may plead in excuse or extenuation of themselves the vagueness and uncertainty of medical knowledge of the laws of hereditary action. We are unable to give them exact and positive information when they apply to us, and they naturally shelter themselves under the uncertainty. Were our knowledge exact, as we hope it will some day be, we could foretell the result with positive certainty in each case, and so speak with more weight of authority. It is one of the first and most pressing tasks of medical inquiry to search and find out the laws of heredity, mental and bodily, in health and in disease, and, having discovered exactly what they are, to apply the knowledge purposely to the improvement of the race —that is, to prevent its retrogression and to promote its progress through the ages. I see no reason to doubt that by discovery of these laws and intelligent practical use of our discoveries we might in the fullness of time produce, if not a higher species of beings than we are, a race of beings, at any rate, as superior to us as we are superior to our primeval ancestors; the imagination of men seems, indeed, in the gods which they have created for themselves, to have given form to a forefeeling of this higher development.— Prof. Maudsley, *in Popular Science Monthly.*

COLOGNES FOR THE SICK ROOM.

Our pharmaceutists are well aware of the fact that during the past years we have had innumerable compounds and chemicals offered as antiseptics, the merits of each being vaunted and extolled in its turn. After repeated

trials of these new remedies, there is still a feeling predominant among those interested in the subject, that the desideratum has not yet been acquired. Some of the best disinfectants are in themselves objectionable; they either possess a disagreeable odor, or will stain and corrode. Ferrous sulphate (copperas) and manganous sulphate, though not really offensive, are comparatively inert. Iodate of calcium prevents decomposition, but if used as a local application causes too much pain. Acetic acid or vinegar is at first grateful and refreshing, but becomes sickening. Chloride of lime (erroneously so-called), as the formula shows, Ca (OCl) Cl, is an uncertain compound, whose virtue depends wholly upon the amount of free chlorine it liberates; chlorine being an irritant, corroding gas, no one would desire to have it in a room containing articles of vertu or delicate metallic ornaments. Potassæ permanganas (permanganate of potassa) is also a very good disinfectant; but unless sprinkled and brought into contact with the air, is not so effective as thought, and in sprinkling the solution, it will necessarily produce stains upon everything it may come in contact with; hence this is not at all desirable. Hydrate chloral is quite offensive, and the vapor stupefying. Acid carbolic or phenol, to which so much has been ascribed, is perhaps the best antiseptic we have in use at the present day, but its odor is certainly intolerable to an invalid; its preparations are less useful as they are less offensive.

I have now fully delineated the objections to the various disinfectants for the use of the sick-room, as per my investigations and experience. What we need, in my opinion, is a preparation that shall possess equal, if not greater, efficacy than any now in use, without irritant properties and unpleasant odor. Such a body, we hope is to be found in salicylic acid.

No theory as to the manner in which salicylic acid exerts its influence has been advanced, but it probably acts as an anti-ferment, and in this manner annihilates the organic bodies produced by fermentation.

The following formulas are such as I have experimented with to my own satisfaction, and only hope they may prove as effectual and as satisfactory in the hands of others:

No. 1 ℞—Acidi salicylici.....ʒ ss.
Spiritus vini rectificati.....f ʒ iv.
Olei cinnamomi.....gtt. j.
" bergamii.....gtt. xv.
Balsami Peruani.....f. ʒ ss.
Make a solution.

In order to make a solution of the above formula, dissolve the balsam of Peru in the spirits and filter, then adding balance of ingredients. The aromatics used in perfuming the above solution are as nearly chemically compatible to salicylic acid as practicable.

No. 2. ℞—Acidi salicylici.....gr. xx.
Olei gaultheriæ.....gtt. v.
Spiritus vini rectificati diluti.....f ʒ ij.
Mix.

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In the above recipe, in the place of olei gaultheriæ you may add same amount of olei anisi, which is also of itself a powerful deodorizer, and may be preferred by many.

The basis of these solutions are salicylic acid, and any other combinations of odors can be added if desired which would harmonize with the salicylic acid. I give one for an example:

Salicylic acid ....gr. xx.
Farina cologne.....f ℥ ij.
Mix.

You will find any one of the above recipes adapted for the use in sick-chambers to neutralize the infected atmosphere attending fevers. In typhoid fever it will neutralize the fecal evacuations, which are pre-eminently contagious. In rooms that have been closed for months, without necessary ventilation, it would destroy the microscopic fungous growths inevitably present. The lotion should be diffused in the room with the aid of a spray tube or atomizer. Its presumptive analogy to benzoic acid would suggest its application as a cosmetic, the lotion to be added to the water used for ablution. A dilution applied to erysipelas is productive of ease to patients. Its balsamic properties promote the healing of cuts and sores, besides freeing them from morbid atmospheric influences.

I hope I have shown the many advantages and powers of salicylic acid over other disinfectants to the entire satisfaction of the readers.

Although, owing to the comparatively high cost of salicylic acid, it would possibly not be brought into general use, yet for minor purposes of disinfection its introduction in such a form will doubtless be met with a fair demand.

The name of such a preparation might be appropriately called *Lotio Antiseptica Fragrans* (Fragrant Antiseptic Lotion), which, in my opinion, gives the properties of the lotion in its name.—GEORGE LEIS, *in Druggists' Circular*, April, 1877.

SULPHO-CARBOLATE OF SODA IN SCARLET FEVER, DIPHTHERIA, ETC.

Dr. G. D. Beebe, of Chicago, in a communication to the *Tribune* of that city, maintains that scarlet fever, diphtheria, erysipelas, and certain other forms of epidemic or contagious diseases, owe their malignity to septic germs or living organisms in the blood. He says that he came to this conclusion with regard to diphtheria more than ten years ago, and accordingly the tried internal administration of carbolic acid to destroy the germs. The results were satisfactory, many desperate cases recovering rapidly under this treatment. He was subsequently led to regard erysipelas as of septic origin, and the certainty with which the disease is arrested by the internal use of an efficient antiseptic seems to him a complete demonstration of this view. Fully eight years ago he predicted that scarlet fever would some

time be proved to be as clearly of septic character as diphtheria, but it is only within the past two years that he considers this to have been demonstrated. He goes on to say :—

The first antiseptic administered internally, in my own practice, was carbolic acid ; but it was never used with entire satisfaction, because it could not be diffused through the blood in sufficient quantity to destroy the living germs, without producing toxic effects of its own ; and it was, besides, objectionable on account of its odor and taste. The sulphites, especially the sulphite of soda, was found to be quite diffusive, but lacked energy, and hence efficiency. In the chemical combination of the carbolic acid with the sulphite of soda (or the sulpho-carbolate of soda) we have all the objectionable qualities reduced to the minimum, while all the desirable properties are retained.

During nearly two years I have administered this salt in many hundreds of cases of scarlet fever and diphtheria, as well as a reasonable number of cases of erysipelas and puerperal fever—both with a view to the prevention of epidemic contagion and in the treatment of these forms of disease.

The sulpho-carbolate of soda is readily soluble, and very diffusive when brought within reach of the absorbents. It is odorless, and of a taste differing but little from soda.

By its administration the blood and tissues of the human body may be thoroughly disinfected without exciting any toxic effects of the drug. Administered to children breathing an atmosphere loaded with scarlet fever or diptheritic contagion, it acts as an absolute preventive, with exceptions so rare, and with symptoms so slight when any appear, that one is forced to believe that the fault was rather in an insufficient dose than in the agent. Given when either of these diseases has developed an attack, and within a few hours the activity of the disease has ceased, and the remaining symptoms speedily fade out into health.

I cannot dismiss this subject without a warning to those who pretend to make use of this agent, but use so small a quantity as to be utterly valueless. I do not know that this agent posesses any other therapeutic properties than as an antiseptic ; and to be useful as such, it must be given in quantity sufficient to disinfect the blood, otherwise it will be as useless in the face of these diseases as the spray of an atomizer in extinguishing a conflagration.

SPRING FEVER : HOW NOT TO HAVE IT.

In the *Christian Union*, a writer gives the symptoms and several remedies for a very common complaint, prevalent with almost every one to a greater or less extent at this season of the year :

The hampered body, says the writer, which has been coddled, petted, stuffed with carbon-bearing fats, and calorified in every possible way, begins to protest. The machinery is clogged ; headache, dyspepsia, and the

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thousand nameless sensations of discomfort which we charge to variable weather, afflict and hamper poor humanity. To-day the fog depresses our vital forces, to-morrow the brain is pierced with blinding sunshaft; and so each day's external is made responsible for internal shortcomings. The *litterateur*, in atrabilious humor, afflicts the world with morbid philosophy. The pastor sees weak humanity more than ever sinful, and his Lenten homilies are unconsciously tinctured with a deeper dye for the pangs of his own mortality. The housewife, in overheated rooms, with a monotone of circumscribed care and too little outside diversion, finds dirt and despair in the kitchen, chaos in the nursery, a forlorn hope in her mending baskets.

Among other remedies for people who say, "I always have a bilious attack in the spring," the following seems the most potent:

On rising sponge the body lightly and quickly with cold water, briskly toweling after. It is not necessary that this be a long or laborious operation; the more rapidly the better, with sufficient friction to bring a glow to the skin. If you cannot secure time to go over the whole bodily surface, at least make a point to daily sponge the trunk and arms. Rousing and stimulating the whole system, clearing and opening the pores, it imparts an indescribable freshness and exhilaration, amply repaying the effort. Rehabilitated, you are now ready for your morning bitters, namely, the clear juice of a fresh lemon in a wineglass of water, without sugar. This is a bomb straight at the enemy, for a more potent solvent of bile is not in the *materia medica*. Searching out rheumatic tendency, attacking those insidious foes which are storing up anguish against our later days—calculi—it pervades the system like a fine moral sense, rectifying incipient error. It is needful, perhaps, to begin with two lemons daily, the second at night just before retiring.

A primitive but most efficacious prescription, which corrected the physical reaction after a pork-eating winter for our ancestors, was a wineglass full of very hard cider, made effervescent by a crumb of sal soda. More potent and palatable is the concentric force of the pure lemon acid.

We venture to claim for this self-treatment alone, faithfully applied, more relief for the body and stimulus to the mind than from a battery of pills or a quarts of herb decoction.

ALCOHOL AS AN ARTICLE OF DIET. — Dr. T. Edes, Professor of Materia Medica in Harvard University, read a paper on this subject at the last meeting of the American Social Science Asssociation, in which he comes to certain conclusions, which are summarized in the *Boston Medical and Surgical Journal* as follows:—

1. Under some circumstances alcohol may be a food. These are:—

(*a.*) The deprivation of nourishing and sufficiently varied and abundant rations, as in the case of soldiers, sailors, laborers, etc.

(*b.*) When for any reason ordinary food is not well assimilated, or the

system has become habituated to alcohol, as in some rare intances of habitual topers and in some wasting diseases.

This substitution should be a matter of necessity and not of choice.

2. The healthy man, with a full and varied supply of food, needs absolutely no alcohol. Wine with food sometimes assists digestion; but the digestion which needs the aid is either enfeebled or overburdened. The most severe and long continued labor can be carried on better without alcohol than with it. This is in most cases especially true of mental labor.

3. In the few cases in which this is not true, and where a small quantity of alcohol suffices merely to restore the normal vigor without excitement, the previous condition is probably one of somewhat impaired vitality, perhaps more especially affecting the heart. As an addition to a diet already sufficient, alcohol is to say the least, useless in perfect health.

4. An occasional use of light wine or beer is a luxury and not a necessity. Experience shows that such a use cannot be regarded as seriously detrimental either to bodily or mental vigor.

5. After a fatiguing day's work, as a relaxation and agreeable change, or as a prelude and assistance to the digestion of more appropriate food, alcohol may be looked upon as approaching more nearly to a true stimulant or restorative action than under any other circumstances in health. We then expect from it neither intoxication nor reaction.

6. An habitual overdose of alcohol leads to degeneration of important organs and undermines the vital powers.

7. There may be moral reasons for total abstinence entirely distinct from the physiological.

8. The introduction of the use of light wine and beer, though not desirable in a community already in a state of ideal physical and moral perfection, is highly desirable as a substitute for the use of stronger liquors.

SCIENTIFIC MISCELLANY.

FRUIT LISTS AND FOREST TREES FOR KANSAS.

The following fruit list was prepared some three years ago with the aid of Prof. S. T. Kelsey, then a resident of the State, and one of the most practical fruit growers in the West. It has in the main stood the test since that time. It was then prepared to answer the many questions relating to fruit growing in the State, and is now reproduced for the same reason:

GENERAL LIST.

Summer Varieties, in the Order of Ripening.—Carolina Red June, Early Harvest, June Sweet, Cooper's Early White.

Autumn Varieties, in the Order of Ripening.—Lowell, Maiden's Blush, Rambo, Barley's Sweet, Fameuse.

Winter Varieties, in the of Order Ripening.—Jonathan, Wagner, Missouri Pippin, Winesap, McAfee's Nonsuch, Rawle's Janet or Geneting, Ben Davis, Gilpin or Little Romanite.

ADDITIONAL LIST.

Summer Varieties, in the Order of Ripening.—Early Pennock, Golden Sweeting, American Summer Pearmain.

Autumn Varieties, in the Order of Ripening.—Fall Wine, Gravenstein, Buckingham, Smokehouse, Wine (syn. Pa. Redstreak), Ortley.

Winter Varieties, in the Order of Ripening.—Yellow, Belleflower, Red Winter Pearmain, or Red Lady Finger, Smith's Cider, Roman Stem, Swaar.

PEARS.

Standards, in the Order of Ripening.—Bartlett, White Doyenne, Seckel, Lawrence, Beurre Easter.

Dwarfs.—Bartlett, Louise bon de Jersey, Duchesse'd' Angouleme, Beurre Deil, Ott, Seckel, Beurre Easter.

Pear blight has destroyed most of the pear orchards planted at an early day. No locality, kind of soil or exposure seem to have an immunity from this destructive disease. It is a serious question whether this delicious fruit can be grown successfully in Kansas. No other obstacle seems to be in the way. Trees grow thriftily, and bear immense crops, until overtaken with blight.

PEACHES.

Hale's Early, Early Tilloston, Early York, Coolidge's Favorite, Stump the World, Old Mixon Free, Yellow Alberge, President, Gross Mignonne, Morris White, Heath's Cling, Ward's Late Free.

Good yields of peaches may be relied on once in three years. A few favored localities will do better than this, but they are exceptional.

CHERRIES.

Early Richmond, English Morello.

PLUMS.

The improved varieties of this fruit do not succeed well in this State on account of the curculio. Occasionally a person will secure partiial crops of the Lombard, German Prune, and Blue Damson, by destoying the curculio each day, but it becomes an expensive luxury. Among the wild varieties, however, occasionally one is found that is very good. Selections have been made in Wyandotte county of some three varieties, one red and two amber color, that ripened in succession, the first in July. They are thin-skinned, sweet, and entirely free from that peculiar astingent property that is so peculiar to the wild varieties. We are informed that in the southwestern part of the State, near the Arkansas river, there are some very good varie-

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ties, that have found their way to the Topeka, Kansas City and other markets, in the eastern portion of the State.

GRAPES.

General List.—Concord, Ives Seeding. The varieties succeed well in all parts of the State. The Concord is the grape for the million. The Ives has the merit of ripening about ten days earlier than the Concord, and therefore lengthens the season. This, however, can be accomplished with the Concord alone, by planting upon different exposures. A southern or eastern exposure will ripen the fruit from eight to twelve days earilier than a northern or western.

Additional List.—Delaware, Martha, Catawba, Goethe, Allen's Hybrid, Dracut Amber. Those mentioned in this list (and many other varieties might be named) succeed well in some localities, but are not reliable throughout the State for general culture.

OTHER SMALL FRUITS.

Currants.—Large Red Dutch, White Dutch, White Grape, Cherry. Currants do well in Kansas if properly shaded and thoroughly mulched. The north side of an east-and-west fence is a good place.

Gooseberries—Houghton's Seedling, American Seedling.

Blackberries.—Kittatiny.

Raspberries.—Doolittle's, Miami.

Strawberries.—Wilson's Albany.

FOREST TREES.

This and the succeeding list was furnished by Prof. S. T. Kelsey:

For Forest.—Black Walnut, Cottonwood, Silver Maple, Osage Orange, Ash and Red Cedar.

Ornamental.—Ash, Elm, Catalpa, Box Elder, Osage Orange, Sycamore, Golden and White Willows.

Evergreens.—Red Cedar, Austrian, Scotch and White Pines.

Hedge.—Osage Orange.

The following list of twelve varieties of apples best adapted to Kansas was prepared, by request, by W. E. Barnes, a nurseryman of ripe experience, of Vinland, Douglas county. Mr. B. places Jonathan in the fall list. Northern varieties ripen earlier here, and it is hard sometimes to make a distinction between late fall and early winter varieties:

Summer.—Red June, Cooper's Early White, Lowell.

Fall.—Maiden's Blush, Jonathan, Pennsylvania Red Streak.

Winter.—Missouri Pippin, Ben Davis, Winesap, Willow Twig, Rawle's Genet, McAfee's Nonsuch.—Hon. Alfred Gray, *Secretary Kansas State Agricultural Society.*

A Small Flower Garden.—A writer in the *Western Farm Journal* recommends for a small flower garden the following list, as they do not require

treatment, are good sturdy varieties, will stand neglect, yet do well: Asters, balsams, dianthus, petunias, phlox, calliopsis, verbenas, sweet peas, mignonette, zinnias, marigolds and portulacas. The same writer again says: "The plants I have named will afford a profusion of flowers from June to October. Phlox will be the first to blossom, and then petunias will come on, and both of these flowers continue to increase in beauty until hard frosts come. Asters will be in perfection in August and September. Calliopsis begins to blossom in July, and nearly all the others come on early in that month. If old flowers are removed and not allowed to go to seed, you will have a much greater profusion of bloom. If you do not remove faded flowers, but allow them to perfect seed, you will soon see that your plants are losing a large share of their former glory. You can't expect a plant to ripen seed and bloom profusely at the same time."

Analysis of Sweet Springs Water, Saline County, Mo.

	Grains.
Chloride of Sodium	89.91773
Chloride of Potassium	3.39796
Chloride of Lithium	0.04756
Chloride of Magnesium	22.29123
Chloride of Calcium	14.72127
Bromide of Magnesium	0.11801
Sulphate of Lime	9.45713
Carbonate of Lime	9.56312
Carbonate of Iron	0.56656
Carbonate of Manganese	0.00190
Alumina	0.08921
Silica	1 08471
Organic Matters	4.05300
Total	155.00028

Per gallon 231 cubic inches.

Origin of Petroleum.—Mr. H. Byasson has been led by the following experiment to give a scientific explanation of the formation of petroleum: If a mixture of vapour of water, carbonic acid, and sulphuretted hydrogen be made to act upon iron heated to a white heat in an iron tube, a certain quantity of liquid carburets will be formed. This mixture of carburets is comparable to petroleum. The formation of petroleum can thus be naturally explained by the action of chemical forces. The water of the sea, penetrating into the cavity of the terrestial crust, carries with it numerous materials, and especially marine limestones. If the subterranean cavity permits these new products to penetrate to a depth where the temperature is sufficiently high, in contact with metallic substances, such as iron or its sulphurets, we have a formation of carburets. These bodies will form part of the gases whose expansive force causes earthquakes, volcanic eruptions, etc. Petroleum is always found in the neighborhood of volcanic regions or along

mountain chains. In general it will be modified in its properties by causes acting after its formation, such as partial distillation, etc. Petroleum deposits will always be accompanied by salt water or rock salt. Often and especially where the deposit is among hard and compact rocks, it will be accompanied by gas, such as hydrogen, sulphuretted hydrogen, carbonic acid, etc.—*Revue Industrielle.*

CHEMICAL PRIZES.—Among the prizes offered by the German *Verein zur Beförderung des Gewerbfleisses*, the following may prove of interest to our readers:

A silver medal, or its value, and 900 marks (about $200) for an opaque red enamel for gold, silver, copper and bronze.

A gold medal, or its value, and 3,000 marks, for a substitute for caoutchouc, the same for a suitable substitute for gutta percha.

A prize of 1,000 marks for a concise, critical and practical treatise on cements; also 1,500 marks for the best investigation of the cause of a change in the zero point of thermometers, with a method of preventing or remedying it.

A prize of 2,000 marks for the best series of iron and manganese alloys; at least twenty samples to be prepared, containing from 0.5 to 5 per. cent. of manganese.

TO DISTINGUISH BETWEEN COTTON AND WOOL IN FABRICS.—Ravel out the suspected cotton fibre from the wool and apply flame. The cotton will burn with a flash, the wool will curl up, carbonize, and emit a burned, disagreeable smell. Even to the naked eye the cotton is noticeably different from the filaments of wool, and under the magnifier this difference comes out strongly. The cotton is a flattened, more or less twisted, band, having a very striking resemblance to hair, which, in reality, it is; since, in the condition of elongated cells, it lines the inner surface of the pod. The wool may be recognized at once by the zig-zag traverse marks on the fibres. The surface of wool is covered with these furrowed and twisted fine cross lines, of which there are 2,000 to 4,000 in an inch. On this structure depends its felting property. Finally, a simple and very striking chemical test may be applied. The mixed goods are unravelled, a little of cotton fibre put into one dish and the wool in another, and a drop of strong nitric acid added. The cotton will be little or not at all affected; the wool, on the contrary, will be changed to a bright yellow. The color is due to the development of a picrate.—*Warehouseman.*

THE *Gardener's Chronicle* announces a new material for paper in a well known American grass, *Zizania aquatica*. It is stated that the Zizania yields fully as much of the raw material as esparto, and has the great and peculiar merit of being comparitively free from silicates. Paper made from it is

quite as strong and quite as flexible as that made from rags; it is easily bleached, economical in respect of chemicals, pure in color, and remarkably free from specks and blemishes. It is especially recommended for the manufacture of printing paper. The grass grows in enormous quantities in our Canadian Dominion, on the shores of Lakes Erie, St. Clair, Ontario, &c., and it is affirmed that a supply of 100,000 tons annually may be looked on as certain. Its habitat is swamps, ponds, and shallow streams, where it grows to a height of from 7 to 8, or even to 12 and 14 feet. The structure is similar to that of rice, except that the flowers are unisexual. The grains are largely used as an article of food by the native Indians, some tribes depending on them to a large extent for their subsistence. The flavor is said to be superior to that of most other cereals, and it has long been known from these properties as "Canada Rice."—*Nature.*

Sawdust in Rough Casting.—Siehr recommends very highly the use of sawdust in mortar, as superior even to hair for the prevention of cracking, and subsequent peeling off, from rough casting under the action of storms and frost. His own house, exposed to prolonged storms on the sea-coast, had patches of mortar to be renewed each spring; and, after trying without effect a number of substances to prevent it, he found sawdust perfectly satisfactory. It was first thoroughly dried, and sifted through an ordinary grain sieve, to remove the larger particles. The mortar was made by mixing one part of cement, two of lime, two of sawdust and five of sharp sand, the sawdust being first well mixed dry with the cement and sand.—*Scientific American.*

Dried Eggs.—A large establishment has been opened in St. Louis for drying eggs. It is in full operation, and hundreds of thousands of dozens are going into its insatiable maw. The eggs are carefully "candled" by hand—that is, examined by light to ascertain whether good or not—and are then thrown into an immense receptacle, where they are broken, and by a centrifugal operation the white and yoke are separated from the shell very much as liquid honey is separated from the comb. The liquid is then dried by heat, by patent process, and the dried article is left, resembling sugar; and it is put in barrels and is ready for transportation anywhere. This dried article has been taken twice across the equator in ships, and then made into omelet, and compared with omelet made from fresh eggs in the same manner, and the best judges could not detect the difference between the two. Is this not an ages of wonders? Milk made solid, cider made solid, apple butter made into bricks! What next?—*Philadelphia Trade Journal.*

The Smithsonian Institution.—Professor Joseph Henry says that he has been trying for years, in regard to the Smithsonian Institution, to get

the government to understand that the great testator never intended, by his munificent gift, to accumulate a mere deposit of scientific works, but to collect all manner of new information for distribution among the nations of the earth. He has at last accomplished this. Chief Justice Waite takes the same view, and the institution is now sending contributions of American discoveries, science, art, anliquities, history and inventions generally, to more than 2,000 universities and colleges in every civilized portion of the globe, and these in exchange return to us the printed evidence of their own successful reseaaches in in all these various studies and inquiries. Both these contributions from us to distant nations and from the distant nations to us are delivered free of cost, by order of the respective governments. Owing to careful investments in United States securities, there remains to-day to the credit of the institute $714,000.—*Scientific American.*

TRIALS have been made in Rome of a solution of chloride of calcium as a substitute for water in laying dust in streets, and the results are said to have been highly satisfactory. The dampness communicated to the road remains for a whole week. The road remains damp without being muddy, presenting a hard surface, on which neither the wind nor the passing of pedestrians or has any effect.

EDITORIAL NOTES.

THE eleventh annual meeting of the Medical Society of the State of Missouri was held in this city, during the third week of April, and was attended by about eighty physicians from various portions of the State. Dr. J. W. Trader, of Sedalia, presided, and Dr. Chesney, of St. Joseph, acted as Secretary, *pro tem.*, in the absence of Dr. Schauffler, the regular Secretary.

Very interesting papers were read by Drs. Higgins, Brown, Richmond, Spencer, Glasgow, Porter, Todd and Lewis.

The officers elected for the ensuing year are as follows: *President*—F. M. Johnston, of Platte City. *First Vice President*—D. R. Porter, Kansas City; *Second*, E. C. Evans, Sedalia; *Third*, N. F. Essig, Plattsburg; *Fourth*, W. C. Glasgow, St. Louis; *Fifth*, P. S. Fulkerson, Lexington. *Recording Secretaries*—A. J. Steele, St. Louis, E. W. Schauffler, Kansas City. *Corresponding Secretary*—C. L. Hall, Marshall, Mo.; *Treasurer*—Jacob Geiger, St. Joseph.

The next meeting will be at Brownsville, Mo.

ON the evening of April 15th, the Rev. J. G. Roberts, pastor of the Con-

gregational church, of this city, delivered a very able and interesting lecture upon "The Conflict between Science and Religion," which was listened to with marked attention by his audience, and was subsequently published in the *Journal of Commerce*.

Dr. George E. Heydon, of this city, has been delivering a course of scientific lectures in the neighboring towns, that have been very well received as we are informed.

General Di Cesnola's book on Cypriote antiquities will be published by Murray this fall. Title, "Cyprus, its Ancient Cities, Tombs and Temples." It will be published in splendid style; 500 royal octavo pages and more than 500 costly illustrations, Mr. Murray sparing no expense to make this contribution to antique art worthy of both the subject and the illustrious author. Every gem in General Cesnola's antique collection will be perfectly reproduced in its pages.

BOOK NOTICES.

Popular Science Monthly. May, 1877. Conducted by E. L. Youmans. Published by D. Appleton & Co., New York. $5.00 per annum; single numbers, fifty cents.

Contents for May: Gar-Pikes, Old and Young, by Prof. Burt G. Wilder, illustrated. Mesmerism, Odylism, Table-Turning and Spiritualism, by William B. Carpenter, LL. D., F. R. S. Aqueducts, by William E. Simmons, illustrated. Gravitation and How it Works, by Granville F. Foster. On the Habits of Ants, by Sir John Lubbock, Bart. The New Star in the Constellation of the Swan, by Amédée Guillemin, illustrated. Antique Marbles, by John D. Champlin, Jr. On the Wonderful Divisibility of Gold and Other Metals, by Alexander E. Outerbridge, Jr. Movements of Jupiter's Cloud-Masses, by Richard A. Proctor. Toadstool-Eating, by Julius A. Palmer, Jr. Sketch of President Barnard, with portrait. Correspondence. Editor's Table: Mental Overwork under the Competitive Prize System—The Relative Importance of Ideas—Concerning "Blue Glass." Literary Notices: Bagehot's English Constitution, and other Essays—Spencer's Principles of Sociology—Prescott's Electricity and the Electric Telegraph—Tyndall's Lessons in Electricity—Wright's Philosophical Discussions—Wallace's Russia, etc. Popular Miscellany: Cotton Culture in Egypt—Testimonials to Mr. Darwin—Ignorant Enterprise—Production of Near-Sightedness in Schools—Astronomical Observations on the Rocky Mountains—Influence of Heat on Galvanic Conductivity, etc. Notes.

Strength and Calculation of Dimensions of Iron and Steel Constructions, with reference to the latest experiments. Translated from the German of J. J. Weyrauch, Ph. D., Prof. Polytechnic School of Stuttgart, with four folding plates. New York: D. Van Nostrand, publisher, 1877.

This little work of 112 pages is designed to give the general results of

many experiments lately made in Germany, England, Sweden and America, to determine the properties of iron and steel, and especially to point out some serious errors in the methods of calculating the dimensions of constructions of these metals, which have led engineers into erecting insecure structures in bridges and buildings. The many accidents occurring in railroad bridges and large public buildings lately, render such a work especially valuable just at this time, and it is claimed that by its careful study practical engineers will be placed at the present standpoint of critical judgment.

We have quoted two chapters from this brochure, under the head of Technology, which give an idea of the general scope of the first part. The remainder of the work is devoted to similar subjects of discussion, together with formulas, calculations, laws, tables and plates, all of which must be of inestimable advantage and value to civil engineers.

"SHALL WE EVER REACH THE POLE?" London: Provost & Co., 36 Henrietta Street. 1877.

This is a pamphlet by an anonymous writer, who takes the remarkable position that the earth must be hollow around the axis, in consequence of its rotary motion, *i. e.*, that the axis is a kind of cylinder more or less enlarged as the velocity of the rotary motion about it varies.

Various other novel propositions respecting the conditions at the Poles are supported with considerable ingenuity, and the work is well worthy of perusal.

CIRCULAR 6. MONTHLY REPORTS OF THE KANSAS STATE BOARD OF AGRICULTURE, for February and March, 1877, by ALFRED GRAY, Secretary.

The Board of Agriculture of the State of Kansas has wisely resolved to expend the appropriations, heretofore made by the legislature for annual fairs and cattle shows, upon official publications, such as annual and monthly reports, for general distribution. These reports are carefully prepared by the secretary, Hon. Alfred Gray, who is a most able and efficient officer.

The number before us contains a large amount of valuable and interesting information concerning the soil, climate, products, railroads, public lands, cost of living, taxes, etc., which must necessarily be of great service to those persons proposing settling in Kansas.

PUBLICATIONS RECEIVED.—Popular Science Monthly for May, 1877; Library Table—New York: American Bookseller; Chicago Field, Vol. 7, No. 9; Fruit Recorder, Rochester, New York; Journal of Applied Science, London, January, February, March and April, 1877; Druggists' Circular and Chemical Gazette, April and May, 1877, New York; American Meteorologist, J. H. Tice, St. Louis, March, 1877; Description of Sweet Springs, Brownsville, Mo.; Catalogue Marietta (Ohio) College, 1876–7; Monthly Report State Board of Agriculture, Kansas; Leavenworth *Times*, daily; Boston Journal of Chemistry, April, 1877.

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WEATHER RECORD FOR APRIL, 1877.

Day.	Prof. Tice's Forecasts.	Signal Service "Indications."	Actual Observations at Kansas City.	7 A. M.	2 P. M.	10 P. M.
1	1st to 5th variable, *F. b.,	clear, R. t., warm.	clear and very windy.	35°	45°	33°
2	R. t., cloudy and threat-	F. b., cooler, cldy.	cloudy and variable.	25	40	35
3	ing weather, raining	warmer, clr, cldy.	snow & rain A. M., clear P. M.	35	51	45
4	with severe storms in	" " "	clear A. M., thund'r stm P. M.	40	61	44
5	places.	R. t., F. b, clear.	pleasant all day.	41	77	61
6	6th to 8th †R. b., F. t.,	" " "	" "	51	71	58
7	clear and	" " "	cloudy and raining all day.	51	53	52
8	fair weather.	F. b., cloudy.	" " "	45	50	48
9	9th to 11th. F. b., R. t.,	" " rain.	clear A. M, cloudy P. M.	44	53	42
10	cloudy and threatening,	" "	cloudy all day.	41	50	44
11	with rain in places.	R t, F. b., cloudy	pleasant but cloudy.	47	60	53
12	12th to 14th, R. b., F. t.,	" " "	cloudy and sprinkling.	47	57	52
13	with clear or	" " "	clear and pleasant all day.	50	61	50
14	fair weather.	" " "	" " "	46	61	52
15	15th to 18th, F. b., R. t.,	warmer, rain.	cloudy A. M., clear P. M.	50	72	63
16	cloudy and threatening,	cloudy & stormy.	rained hard, high west wind.	60	65	69
17	with heavy rains and	rain, cldy, stormy	cldy all day, storm at night.	60	74	57
18	storms in places.	rain, cool'r, b.wnd	cloudy A. M., rained all P. M.	60	61	54
19	19th to 20th, R. b, F. t.,	cloudy, high wind	cloudy and drizzling all day.	51	56	48
20	clear or fair.	" " "	clear and pleasant.	44	61	51
21	21st to 23d, F. b., R. t.,	clear, R. t., s wind	" "	54	69	57
22	cloudy and threatening,	cldy, warmer, F. b	" "	58	76	67
23	with rains.	cloudy and cool.	cloudy "	56	64	58
24	24th to 25th, R. b., F. t.,	" "	" "	47	70	62
25	clear or fair.	cool, clear fair.	cloudy and cool, n. e. wind.	50	60	53
26	26th to 29th, F. b., R. t.,	F. b., cool, cldy.	cldy & cool, rained at night.	51	68	56
27	cloudy and threatening,	R. t., warm.	clear & warm, rained at night.	59	62	46
28	with heavy storms in	F. b., cool, cloudy	cloudy and cold.	37	37	36
29	places.	" " "	cloudy and cold, n. wind.	37	50	41
30	30th, R. b., F. t., clear.	R. t., " "	clear and pleasant, with frost.	40	64	46

* Falling barometer, Rising temperature; † Rising barometer, falling temperature.

As Prof. Tice's forecasts are intended to cover the entire continent he divides the time into periods of three or four days each, because it requires that length of time "for a storm-centre to pass from west to east across the continent." The Signal Service predictions apply to the Upper Mississippi and Lower Missouri Valleys.